S. HRG. 101-362

EARTHQUAKE HAZARDS REDUCTION PROGRAM

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

ON

NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM

APRIL 7, 1989

Printed for the use of the
Committee on Commerce, Science, and Transportation

U.S. GOVERNMENT PRINTING OFFICE

24-223 O WASHINGTON : 1989

5261-13

For sale by the Superintendent of Documents, Congressional Sales Office
U.S. Government Printing Office, Washington, DC 20402

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ERNEST F. HOLLINGS, South Carolina, *Chairman*

DANIEL K. INOUYE, Hawaii
WENDELL H. FORD, Kentucky
J. JAMES EXON, Nebraska
ALBERT GORE, JR., Tennessee
JOHN D. ROCKEFELLER IV, West Virginia
LLOYD BENTSEN, Texas
JOHN F. KERRY, Massachusetts
JOHN B. BREAUX, Louisiana
RICHARD H. BRYAN, Nevada
CHARLES S. ROBB, Virginia

JOHN C. DANFORTH, Missouri
BOB PACKWOOD, Oregon
LARRY PRESSLER, South Dakota
TED STEVENS, Alaska
ROBERT W. KASTEN, JR., Wisconsin
JOHN MCCAIN, Arizona
CONRAD BURNS, Montana
SLADE GORTON, Washington
TRENT LOTT, Mississippi

RALPH B. EVERETT, *Chief Counsel and Staff Director*
WALTER B. MCCORMICK, JR., *Minority Chief Counsel and Staff Director*

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

ALBERT GORE, JR., Tennessee, *Chairman*

JOHN D. ROCKEFELLER IV, West Virginia
LLOYD BENTSEN, Texas
JOHN F. KERRY, Massachusetts
RICHARD H. BRYAN, Nevada
CHARLES S. ROBB, Virginia

LARRY PRESSLER, South Dakota
TED STEVENS, Alaska
ROBERT W. KASTEN, JR., Wisconsin
TRENT LOTT, Mississippi

CONTENTS

	Page
Opening statement by Senator Robb	1
Opening statement by the Chairman	2
Opening statement by Senator Gore	3
Opening statement by Senator Ford	17
Opening statement by Senator Bryan	18
Opening statement by Senator Danforth	46
Opening statement by Senator Lott	48

LIST OF WITNESSES

Becton, Hon. Julius W., Jr., Director, FEMA; accompanied by Dennis Kwiatkowski, Assistant Associate Director for Natural and Technological Hazards; and Gary Johnson, Chief, Earthquake and Natural Hazards Program Division	89
Prepared statement	92
Questions of Senator Danforth and the answers	97
Bernstein, George, chairman, expert review committee, National Earthquake Hazards Reduction Program	63
Prepared statement	67
Cranston, Hon. Alan, U.S. Senator from California	5
Prepared statement	8
Ketter, Dr. Robert L., director, National Center for Earthquake Engineering Research, State University of New York at Buffalo	19
Prepared statement	25
Peck, Dr. Dallas L., Director, USGS; accompanied by Dr. Robert L. Wesson, Chief, Office of Earthquakes, Volcanoes, and Engineering	99
Prepared statement	102
Suiter, Lacy, chairman, Central U.S. Earthquake Consortium	50
Prepared statement	55

ADDITIONAL ARTICLES, LETTERS, AND STATEMENTS

Kammer, Raymond G., Acting Director, Department of Commerce, letter	113
Stewart, David, director, Southeast Missouri State University, letter	127
White, John A., Assistant Director for Engineering, NSF, letter	122

EARTHQUAKE HAZARDS REDUCTION PROGRAM

FRIDAY, APRIL 7, 1989

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
Washington, D.C.

The subcommittee met at 9:32 a.m. in room SR-253, Russell Senate Office Building, Hon. Charles S. Robb, presiding.

Staff members assigned to this hearing: Mike Nelson, professional staff member; Fiona Branton, minority staff counsel; and Mark Farrell, minority professional staff member.

OPENING STATEMENT BY SENATOR ROBB

Senator ROBB. The hearing of the subcommittee will come to order. Good morning.

In 1977 Congress enacted the Earthquake Hazards Reduction Act, which in turn created an inter-agency National Earthquake Hazards Reduction Program. The purpose of today's hearing is to ask how much progress the nation has made since 1977 in preparing for major earthquakes and what additional steps the Federal government can take to help further minimize the loss of lives and property.

I am pleased to be able to substitute for Senator Gore this morning. I think most of you are aware of the fact that his son had a very serious accident earlier in the week, and our thoughts and prayers are with him.

I must apologize to our first witness for the fact that he is not receiving the attention of the chairman of the subcommittee, who has taken a great deal of interest in this particular topic. I am new to the technical concerns and hope to be able to work with you on them, but do not have the expertise or background that some of those who have been interested in this topic for a long period of time have.

This morning's hearing will pay particular attention to three related issues: how to improve preparedness in the eastern and central United States, where earthquakes are rare but occasionally devastating; how generally to speed the transfer of research findings to those who need the information, especially construction engineers and local officials; and how to improve coordination and leadership in the Federal program.

The threat of earthquakes east of the Rocky Mountains is of particular concern to many of us on this particular committee. My own State of Virginia suffered a medium-sized earthquake, a magnitude 5.8 event, in 1897. Fortunately no deaths or injuries were reported, but the tremor did damage hundreds of buildings and triggered several small landslides.

Much larger earthquakes struck the St. Louis-Memphis area in 1811 and 1812, and a little later this morning we will have a presentation on what could happen if that should reoccur. Few people lived in that particular region then and there were no reported deaths. But a similar event today could kill thousands, cause damage in the billions of dollars, and interrupt natural gas and electric supplies to much of the East.

All through the United States, both East and West, we need to consider how the Federal government can best help the states and local governments strengthen buildings, improve emergency responses, and generally prepare for these rare but destructive natural disasters.

Senator Cranston, our lead witness this morning, helped create the National Earthquake Hazard Reduction Program. Now he has introduced S. 629, a bill to strengthen the program and change the lead agency from the Federal Emergency Management Agency to the U.S. Geological Survey.

I understand that the Office of Management and Budget opposes any change in the lead agency, but we look forward this morning to a full discussion of the pros and cons of this matter.

Senator Cranston's bill provides one mechanism for better coordination between agencies in the earthquake research and better utilization of the program's limited funds. Other mechanisms have been proposed as well. Today we will examine both the need to strengthen the earthquake program and explore the various options for doing that.

I have an opening statement that the Chairman, Senator Hollings, would like to have included in the record and also one from Senator Gore.

(The statements follow:)

OPENING STATEMENT BY THE CHAIRMAN

I am pleased that the Science Subcommittee is holding this morning's hearing on the National Earthquake Hazards Reduction Program and on proposed legislation to strengthen that important effort. I also want to thank Senator Robb for agreeing to chair this hearing on such short notice.

Thirty-seven states, including many of our eastern and central states, run some risk of earthquakes. These disasters may occur less often east of the Rockies than in the western states, but they can be equally devastating. Most people do not know it, but my hometown of Charleston was devastated by a major earthquake in 1886, just over a hundred years ago. More than 60 people died, hundreds of buildings were destroyed, and losses exceeded $5 million. Today in Charleston one can still see "earthquake bolts" placed on homes to repair the damage from the quake.

Charleston's population has grown greatly over the past one hundred years. A repeat of the 1886 quake would cause hundreds of deaths, maybe thousands. The 1886 event was a major earthquake, comparable in magnitude to the recent Armenia quake, which killed tens of thousands and left hundreds of thousands homeless and jobless. That catastrophe reminded us of what a major earthquake can do to an unprepared urban area. Because of concern about the threat that earthquakes pose to lives and property,

Congress passed the Earthquake Hazards Reduction Act of 1977, which in turn created today's interagency earthquake program. Much has been accomplished since enactment of the law. Geologists have mapped active faults. Geotechnical engineers have developed techniques to identify those areas with unstable soils where an earthquake could lead to major building collapses. Structural engineers better understand how to design earthquake-resistant buildings and strengthen old structures. Disaster response managers have learned much about coping with the fires, transportation disruptions, and injuries that a major earthquake will cause.

In many ways, then, the National Earthquake Hazards Reduction Program has been a success. But a great shortcoming exists. We have not yet done enough to apply our new knowledge. Geological maps are often not available to developers and others who could use them. Advances in earthquake-resistant building design often are not put to use by architects and builders. Part of the problem is a continuing lack of public awareness. Part of the problem is that the leadership of the four-agency Federal effort has not done everything it could to improve the transfer to information and technology.

Last month Senator Gore, Senator Wilson, and I joined Senator Cranston in sponsoring S. 629, a bill to strengthen the Federal earthquake program. Senator Cranston proposes to make the United States Geological Survey (USGS) the new lead agency for the earthquake program. USGS has largest budget in the earthquake program and has a large staff of technically trained people who have been instrumental in improving our understanding of earthquakes and in helping Americans prepare for them.

The Federal Emergency Management Agency (FEMA) currently serves as the program's lead agency. That made sense earlier, when improving our capability to respond to earthquakes seemed the most pressing need. Response is still very important, and FEMA will continue to be the principal agency in this area.

But in terms of coordinating the overall Federal earthquake program, the larger issue now has become to match earthquake experts with state, local, and private groups which must plan land use, construction standards, and insurance strategies. In short, we must get the information to the people who need it and who can use it to reduce the risks associated with these terrible natural disasters. Based on the evidence I have seen, I agree with Senator Cranston that USGS is better equipped to lead the overall national effort, given current needs. They have more experts, in more places around the country, and have a long tradition of working with the states to apply the information that researchers generate.

The change in lead agency proposed by Senator Cranston should not be taken as an indication that we want to deemphasize disaster planning, nor do we criticize the small but important steps that FEMA has taken to convey information on seismic-resistant building designs to the states. FEMA has played an important role in the national earthquake program and will continue to do. But historically it has lacked both the resources and, frankly, the high-level expertise and commitment to ensure that the work done by the other agencies in the earthquake program is fully applied in the field. I believe that Senator Cranston's bill will help remedy this situation.

I understand that not all of our witnesses today favor a new role for USGS, and that the Office of Management and Budget apparently opposes any change in lead agency. The Committee is interested in the views of all major parties on these matters, and I look forward to reviewing today's testimony and comments.

I think it is fair to say, however, that several of us on the Commerce Committee remain concerned about whether we have taken all available steps to apply available knowledge, reduce risks, and generally prepare for major disasters. The question we face today, and will continue to grapple with this year, is how to structure the National Earthquake Hazards Reduction Program and its limited resources to ensure that everything possible is done to reduce the risks that these terrible earthquakes pose to our citizens and our country. Today's hearing is an important step in that process.

Opening Statement by Senator Gore

I want to thank my friend, Senator Chuck Robb, for chairing this vital hearing in my absence. I will look forward to reading the transcript and learning the views of our witnesses.

Earlier this week, I spoke in Memphis, Tennessee, at the dedication of the new headquarters of the Central United States Earthquake Consortium (CUSEC), a regional organization for earthquake mitigation and preparedness. I believe that the City of Memphis, the State of Tennessee, and the governors and emergency directors from the seven states of the consortium clearly recognize the tremendous importance of earthquake research and preparation. Today, we need to make sure that the federal government is doing its part.

In addition to reviewing the federal earthquake program, we need to examine the earthquake hazard east of the Rockies. As many of you know, the New Madrid Seismic Zone in the central United States is one the most potent and least understood fau' on this continent. The great quake of 1811 rang church bells as far away as Bost knocked down scaffolding around the nation's Capitol, and in Tennessee made the M sissippi River run backwards. But for most of the past two centuries, the worst earthquake the U.S. has ever seen has been virtually forgotten. According to one estimate, without further precautions, an earthquake of that same magnitude today would kill 3,800 people and cause $30 billion in property damage in Memphis alone.

Through the National Earthquake Hazard Reduction Program (NEHRP), we have made tremendous advances in earthquake research and awareness. The challenge to the NEHRP agencies (the Federal Emergency Management Agency, U.S. Geological Survey, National Science Foundation, National Institutes of Standards and Technology), to the regional organizations like CUSEC, and to state and local officials will be to translate existing research and awareness into concrete action at the community level. It is time to take the lessons we have learned from tragic earthquakes in Armenia and Mexico City and apply them throughout the United States. It is time to consider seismic precautions in designing our utility systems, our buildings, our communications systems, and our survival systems. We know what needs to be done. But we need to do it.

The Earthquake Hazard Reduction Act of 1977, which Senator Cranston authored, was designed "to reduce the risks of life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards reduction program." The first decade of NEHRP advanced our understanding of earthquakes and what should be done to prevent deaths, injuries, and damage from them. Under the aegis of NEHRP, basic research efforts have added greatly to what we know about earthquakes.

Yet despite the program's successes, Members of Congress, structural engineers, state and local emergency management agency directors, and many others are concerned about the direction and future of the program. For example, since the program was established, its funding has declined 40 percent in real dollars. We need to make sure that we allocate adequate funds for critical earthquake research and mitigation programs. At the same time, we need to apply effectively the research and knowledge that we have already developed. I am quite concerned that NEHRP, so successful in studying earthquakes and the associated hazards, has neglected to implement this information or transfer it to the right people. I believe that we need to take a fresh look at the national program. We need to shift the emphasis from basic research to applications with direct impact on hazards reduction.

That is why, after studying the problems in NEHRP, I concluded that we must refocus our efforts on hazard mitigation. And that is why last month I cosponsored Senator Cranston's legislation to amend the Earthquake Hazards Reduction Act of 1977. These proposed amendments will reinvigorate the National Earthquake Hazards Reduction Program, refocusing it on the Act's goal of reducing hazards. I again want to congratulate Senator Cranston on his efforts to improve the national program to reduce the hazards from earthquakes. His legislation has stirred renewed attention to the program.

Regardless of which agency is designated "lead agency," each agency has and will continue to have significant responsibilities. I am considering further amendments such as establishing an international repository at the United Nations for earthquake information and enhancing other areas of technology transfer to ensure that earthquake research does not sit on a shelf gathering dust.

In December, 1987, an expert review committee appointed by FEMA called into question FEMA's role as lead agency for NEHRP. In fact, that committee questioned

whether any agency could satisfactorily run the program which is hampered by insufficient resources and has to coordinate the work of four agencies. Changing the lead agency from FEMA to USGS and clarifying the management and leadership responsibilities are the main parts of the proposed legislation. I realize that any change like this is bound to provoke controversy. However, the field-oriented Survey has a proven record of success, works well with state and local governments, and has a large and highly-respected staff which is extremely knowledgeable about earthquakes. At the same time, I want to be clear that the other NEHRP agencies will continue to have critical roles to play in the program. Our primary concern should not be who is in charge, but rather how will the job get done. Having traveled far in ten years, we need to recalibrate our position and aims and make sure that the NEHRP program is headed in the right direction. I believe that this legislation and today's hearing allow us to review the past and set us on the right track for the future.

Five years ago, Dr. Arch Johnston of the Memphis State University Center for Earthquake Research and Information told my subcommittee something about earthquakes that I will not soon forget. "Possibly within our lifetime, possibly many generations from now," he warned, "a large, destructive earthquake will occur in the eastern United States. Because like nuclear war, such a quake could be devastating, it only makes sense to take precautions." The difference, he said, is that nuclear war can be prevented. With earthquakes, we can only put our best ear to the ground and wait.

Senator ROBB. I am particularly pleased to welcome this morning to lead off the hearing the distinguished senior Senator from California, Senator Cranston. Senator Cranston, we would be delighted to have your testimony, sir.

STATEMENT OF HON. ALAN CRANSTON, U.S. SENATOR FROM CALIFORNIA

Senator CRANSTON. Thank you very much, Mr. Chairman. I am delighted that you are chairing the hearing today.

I have a prepared statement. In the interest of time I will summarize it.

First let me say I am glad to see you here. When I learned that you were going to be chairing the hearing today, I did a little research on earthquakes in Virginia. Some might not know that there was an earthquake in Giles County, Virginia, in 1897 that was felt over an area of 280,000 square miles.

The damage in the epicenter of the quake was comparable to that in Whittier, California, in 1987, where there was a lot of damage . There was not that much damage in the Virginia quake because there was not that much development at that time.

But as you pointed out already, the developments that have occurred in the East since any major quakes would mean that a reoccurrence without adequate preparations could be very devastating and tragic.

Much of the testimony this morning will focus on S. 629, which I have introduced with Senators Hollings, Gore, and Wilson. It is a bill to revise and redirect the National Earthquake Hazard Reduction Act, which I authored back in 1977.

When we initiated this program, our science, engineering and policy knowledge of earthquakes and their impact was very limited. During the last twelve years, we have created both the expertise and the capability needed to make major reductions in earthquake consequences. Also, earthquakes are now viewed as a national, not a regional,

threat, and there are well-mounted preparedness efforts in the Northwest, the Intermountain region, the Midwest, the Southeast, and the Northeast.

Now, through what we have learned since 1977, we have a view that we need to initiate more aggressive, effective actions to prepare for, mitigate, and recover from earthquakes.

It is time, based upon the program's success in its original mission, to reorient the NEHRP from a program focused on building capability and capacity to a focused, goal-oriented, centrally managed effort to develop knowledge and foster application of earthquake hazards reduction.

Research has been the hallmark of the first decade of the NEHRP. It should remain so in the coming decade. While we have made much progress and achieved much, it now needs application.

We recognized very early on that a vigorous research effort was the route to the needed knowledge and understanding of earthquake hazards mitigation, and it provides the training of those that will apply what we know through the practice of their profession.

A strong research and educational effort must remain at the center of research. One of the clear successes of the research has been FEMA's programs to enhance governmental and public earthquake preparedness. In S. 629, we want to see these efforts expanded in scope and proceed with more vigor in all earthquake-prone regions.

Though we are proposing reassigning the lead from FEMA to USGS, we see FEMA doubling its efforts on preparedness, not reducing them. We envision more, not less, emphasis on community-based preparedness; more, not less, effort to moderate earthquake impacts through mitigation; and more, not less, effort to foster efficient, economic recovery of damaged communities.

S. 629 proposes that the U.S. Geological Survey assume the leadership role of the NEHRP, currently under charge of the Federal Emergency Management Agency. This change is proposed for several reasons. USGS is a field-oriented agency, which is especially important if the NEHRP is to emphasize application.

USGS has by far the largest earthquake program staff, over 350, compared to a total of perhaps 20 for all the other agencies combined.

It has the largest appropriation of all the agencies, representing over 50 percent of appropriations. USGS administration and staff have excellent working relationships with states and regions.

The agency is clearly and demonstrably interested in the future of NEHRP.

When we make a change from a loosely coordinated program, which we have now, to a focused, managed program, a change in leadership is both symbolic and functional. This is a first step in the process of strengthening the NEHRP and one that I believe offers significant promise for positive change.

A principal objective of S. 629 is to achieve a more problem-focused program, with more emphasis on applications. We need to undertake recovery planning for communities devastated by earthquakes. This is a key issue in earthquake hazards reduction.

For the private sector, we need action to provide insurance and financial incentives in order to advance seismic safety. We need to move farther and faster on seismic codes and standards for construction. We need a sustained effort to develop the building practices and regulations that can upgrade existing hazardous structures.

The executive order that would promulgate standards for Federal building practices must be implemented. We need good, consistent practices, just as we demand in the private sector.

I would add to this list of examples the need for technology transfer and professional education at the grassroots level. We have simply not done an effective job of training practicing engineers, architects, and public officials in earthquake hazards mitigation.

This is not to say that there is no activity in these areas. In some cases there are small and too often disjointed efforts.

But in the problem-focused approach envisioned by S. 629, these and other objectives would be very visible. They would encompass basic, applied and developmental research, preparedness, and demonstration projects, continuing education, and joint public and private cooperative initiatives at all levels of government.

We have been fortunate that the damaging earthquakes of the past decade have not cast doubt on the wisdom of our original decision to build knowledge and capability before we focus on application.

Though the earthquakes in California, Idaho, Kentucky, Alaska, and Hawaii have caused damage and life loss, they have not forced the massive soul-searching that the Soviets have had to face in Armenia. There the seismic hazard was well known and the engineering well understood, but the practical implementing actions were lacking. The result was tens of thousands of lives lost and tens of billions of dollars in economic damage.

The hazard in many parts of the U.S. is no less certain than it was in Armenia. The challenge that faces us now is to take the actions necessary to use our new capability and capacity for earthquake hazard reduction before we have to face the public and explain our inaction, as the Soviets have been compelled to do.

Twelve years ago when George Brown and I began to discuss the urgency of earthquake hazards, many of our colleagues saw earthquakes as a problem for California, but not for the rest of the nation. The earthquake threat is now recognized to be of national consequence.

The National Earthquake Hazard Reduction Program has been a resounding success, not only in bringing us to a point of recognition of a national issue, but in bringing us to a place where we can act on this threat with clarity, purpose, and lifesaving effect.

Let me add that I am glad to see the Senator from Kentucky here, since that is one of the states that has had a quake in recent years, not terrible damage suffered, but perhaps a warning that we have to be prepared.

Senator FORD. We rang the bells in Boston in 1811.

Senator CRANSTON. That completes my statement, Mr. Chairman. [The statement follows:]

STATEMENT OF SENATOR ALAN CRANSTON
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE
REVIEW OF NATIONAL EARTHQUAKE HAZARD REDUCTION PROGRAM
FRIDAY, APRIL 7, 1989

MR. CRANSTON.

Mr. Chairman, I welcome this opportunity to testify as the Committee reviews our federal earthquake hazards reduction program. We are at both a critical and pivotal point in the federal earthquake effort. With that in mind, I have introduced---with Senators Hollings, Gore, and Wilson---S. 629, a bill to revise and redirect the National Earthquake Hazards Reduction Program, which will also receive comment today.

I'd like to comment briefly on where we have been and where I think we must go. Twelve years ago I authored the National Earthquake Hazards Reduction Act which formed the basis for our federal earthquake mitigation effort. Then---in 1977---and in the years since, the leadership of this Committee has been of prime importance in both inaugurating and maintaining a federal focus on earthquake research and application.

Although this Committee does not need a recitation of the dangers of earthquakes in the United States, it may be useful to remind ourselves that nearly every state in the nation faces some degree of risk from future earthquakes. 39 states---with a population of over 70 million Americans---are wholly or partly in areas that are at high to moderate risk for earthquake damage. While the short term risks seem to be highest in the west, we know that an earthquake as devastating as the one in Armenia is likely in the United States. In some areas of the country it is

virtually certain. Acknowledging the seriousness of the threat is not to cause panic, but to face facts and to get on with the task of preparing to save lives. For while earthquakes are certain, total devastation is not. We can take actions to save lives and property. But there is much yet to do, and given the high probability of serious quakes, little time in which to do it.

During the last twelve years the National Earthquake Hazards Reduction Program has achieved both the capability and the capacity to be more aggressive in its mission. When we initiated this program our science, engineering and policy knowledge of earthquakes and their impact was limited. Limited, too, was the capability of government and business to act on what we knew. Few individuals were capable of effectively advancing the field of earthquake research and application. So our first goal under the Program was to develop knowledge about earthquakes together with a clear capability to use that knowledge. We also needed to bring both knowledge and capability to a point that it accurately reflected the national extent of the earthquake threat and the pressing need to mitigate the impacts of the earthquakes we knew would occur in the future.

Clearly, the first decade of the NEHRP has succeeded in its dual mission. We have created both the expertise and the

capability needed to make major reductions in earthquake consequences, and earthquakes are now viewed as a national, not regional, threat. Whereas earthquake preparedness was once focused only in California and Alaska, we can now point to well-mounted preparedness efforts in the Northwest, the Inter-Mountain Region, the Midwest, the Southeast, and the Northeast. Whereas engineering and scientific research was previously concentrated in western universities, with a few expert individuals in other regions, we now have major efforts and centers of expertise in the east. Whereas the public perception in 1977 was of earthquakes as a western problem, citizens are much more aware of their vulnerability in other areas of the country and they are beginning to seek protection.

These are major shifts in attitude, perception, and expertise, and they are directly attributable to the success of the NEHRP. Now, through what we've learned since 1977, we have what we need to intimate more aggressive, effective actions to prepare for, mitigate, and recover from earthquakes. It is time, based upon the program's success in its original mission, to reorient the NEHRP from a program focused on building capability and capacity to a focused, goal-oriented, centrally-managed effort to develop knowledge and foster application of earthquake hazards reduction.

Research has been a hallmark of the first decade of the NEHRP. It should remain so in the coming decade. While we have made much progress and achieved much that now needs application, we recognized early on that a vigorous research emphasis is the

route to needed knowledge and understanding of earthquake hazards mitigation. And it provides the university training of those that will apply what we know, through the practice of their professions. A strong research and educational effort must remain at the center of the NEHRP.

One of the clear successes of the NEHRP has been FEMA's programs to enhance governmental and public earthquake preparedness. In S. 659, we want to see these efforts expanded in scope and pursued with more vigor in all earthquake-prone regions. Though we are proposing reassigning the lead from FEMA to USGS, we see FEMA redoubling its efforts on preparedness, not reducing them. We envision more, not less emphasis on community based-preparedness, more, not less effort to moderate earthquake impacts through mitigation, and more, not less effort to foster efficient, economic recovery of damaged communities.

S. 629 proposes that the U.S. Geological Survey assume the leadership role of the NEHRP currently under charge of the Federal Emergency Management Agency. This change is proposed for several reasons. USGS is a field-oriented agency, which is especially important if the NEHRP is to emphasize application. USGS has by far the largest earthquake program staff---over 350, compared to a total of perhaps 20 for all the other agencies combined. It has the largest appropriation of all the agencies, representing over 50 percent of appropriations. USGS' administration and staff have excellent working relationships in states and regions. The agency is clearly and demonstrably

interested in the future of the NEHRP. When we make a change from a loosely coordinated program to a focused, managed program a change in leadership is both symbolic and functional. This is a first step in the process of strengthening the NEHRP, and one that I believe offers significant promise for positive change.

A principal objective of S. 629 is to achieve a more problem-focused program with more emphasis on applications. Let me give some examples of what I mean by applications.

Several years ago, provisions were proposed for the seismic-resistant construction of new buildings. In order to make certain that the provisions were sound, a proposal was developed, with considerable voluntary effort, and it was evaluated as outstanding. Yet as this proposal made its rounds of the federal agencies involved in the NEHRP, it was rejected by each agency as not conforming to the agency's mission. It was not that the proposal did not conform to the mission of the NEHRP. It clearly did, and was prepared with that specifically in mind. As a result of this fragmented, individual agency-centered view, the current structure was unable to accommodate a key element in current design and regulation practice. I give this example not to engage in a debate on the merits of the individual project, but to point out that the decision process has become so specific to agency priorities that

large cracks in the NEHRP have developed. There is a compelling need to re-emphasize the problem-focused needs of the NEHRP and to sharpen its attention to applications.

There are other areas of applications that need attention:

Recovery Planning: Recovery is a key issue in earthquake hazards reduction, yet we have not undertaken recovery planning.

Insurance and Financial Incentives: For the private sector, these incentives can be compelling when it comes to voluntary decisions that advance seismic safety. Yet after 12 years we are still performing planning studies. It is time for action.

Seismic codes and standards: These are key elements in regulating construction, yet the initiatives of today are but extensions and refinements of projects completed over a decade ago.

Upgrading existing hazardous structures: This is the clear key to reducing future losses, yet we have made no sustained effort to develop the building practices and regulations to match those that are available for new buildings.

Federal building practices: These can set a standard for communities, but we have yet to promulgate federal directives for federal agencies to follow good, consistent practices -- as we demand in the private sector. An executive order has been drafted, but due to federal inertia it has not been implemented.

I would add to this list of examples the need for technology transfer and professional education at the grass roots level. We have simply not done an effective job of training practicing engineers, architects, and public officials in earthquake hazard mitigation.

This is not to say that there is no activity in these areas. In some cases, there are small and too-often disjointed efforts. But in the problem-focused approach envisioned by S. 629, these and other objectives would be very visible. they would encompass basic, applied and developmental research, preparedness and demonstration projects, continuing education, and joint public and private cooperative initiatives at all levels of government.

Mr. Chairman, up to this point the hallmarks of the NEHRP have been capability and capacity-building, and that has led us to emphasize the generation of knowledge. We now have a fund of knowledge, and incomplete though it is, it is time to add to our emphasis on knowledge an emphasis on implementation. For example, although we know the risk in the Southeast, and although individuals have come forward to lead grassroots-up effort in technology transfer, we have not capitalized on these opportunities. Why? In my view, it is because our objectives have not been clear.

We have been fortunate that the damaging earthquakes of the past decade have not cast doubt on the wisdom of our original decision to build knowledge and capability before we focused on application. Though the earthquakes in California, Idaho,

Kentucky, Alaska and Hawaii have caused damage and life loss, they have not forced the massive soul searching that the Soviets have had to face in Armenia. There, the seismic hazard was well known and the engineering well understood, but the practical, implementing actions were lacking. The result was tens of thousands of lives lost and tens of billions of dollars in economic damage. The hazard in many parts of the U.S. is no less certain than it was in Armenia. The challenge that faces us now is to take the actions necessary to use our new capability and capacity for earthquake hazards reduction before we have to face the public and explain our inaction---as the Soviets now must.

Twelve years ago when George Brown and I began to discuss the urgency of earthquake hazards, many of our colleagues saw earthquakes as a problem for California but not for the nation. The earthquake threat is now recognized to be of national consequence. The National Earthquake Hazards Reduction Program has been a resounding success not only in bringing us to a point of recognition of a national issue, but in bringing us to a place where we can act on this threat with clarity, purpose, and life-saving effect.

Thank you, Mr. Chairman.

Senator ROBB. Thank you very much, Senator Cranston. And thank you for the leadership that you have provided in this area for certainly over two decades. Your proposal is an interesting one that we will explore in due course.

I would tell you that Giles County fortunately is still a relatively rural area in Virginia, so that our imminent danger of massive destruction and loss of human life, even with another quake of that magnitude, probably is not that great there. For the Memphis and St. Louis area, we will hear a different story rather shortly.

I am curious. California certainly has an interest in this particular topic, and we frequently hear about the San Andreas fault and the big which one could strike California. Simply to get our attention and to start things off this morning, would you give us some feel for the potential impact of the Big One that is frequently discussed in California?

Just to give those of us who may not be as familiar with the subject as you are, could you give us some idea of the potential impact? We have been reviewing the Valdez oil spill and know what happened there that has not resulted, at least at this point, in the loss of human life although animal life and aquatic life have been threatened.

Could you tell us about the potential risks of earthquakes, in order, to galvanize the attention of those who might think this is a somewhat esoteric topic?

Senator CRANSTON. It is very hard to estimate how many lives might be lost in a major quake in California. Estimates run from 20,000 lives lost on up. You just cannot tell.

A major quake on the San Andreas fault could total $50 billion or more in damages, with no real limits. It could trigger $60 billion or more in total insurance claims. It could wipe out half of the insurance industry's capital, causing insurers to dump stocks and bonds onto the market all at once and gravely depressing the market.

If major computer and telecommunications centers are hit, as would be the case if S.F. or L.A. were hit, or New York at the other end of the country, the U.S. economic communications labyrinth could be seriously disrupted. Data transfer failures could affect banks everywhere in short order.

Loss of real estate equity or loss of insurance could spur loan defaults and bankruptcies. This would occur on top of the loss of life.

Other consequences could include gas pipeline failure, electrical, sewer, and water line breakage, release of stored toxic substances, breakage of dams and floods, and many, many dams in California would be jeopardized. Rail transportation and highways could be seriously disrupted, bridges knocked down, commercial telephone service knocked out.

Fires would be numerous. That is what happened after the San Francisco quake. It was really a fire that did more damage than the quake. The fire damage at least equalled the quake damage.

Structural failure could be widespread. Injuries could overwhelm medical capacities.

That is just the beginning of a very ugly picture of what could occur.

Senator ROBB. It certainly serves to get our attention in this particular area.

The focus of those who asked to have this particular hearing in the first place was on activities in the central and eastern part of the United States. Does your particular bill increase the preparedness of some of the areas which have not seemed to be as imperiled or threatened by the possibility of earthquakes?

Does it address some of the needs of thos in these areas who are concerned about emergency preparedness, structural design and earthquake risk mitigation?

Senator CRANSTON. Yes. We have had more concern in the West because we have had more quakes there and more damage in modern times and, because of that, perhaps not enough of what has been learned has been applied in the East. But this would be a nationwide, problem-focused redirection of the earthquake program.

And it would be targeted in ways that will help in the East, such as strengthening seismic construction codes, seeing what needs to be done to get communities ready in case a problem emerges, and moderating earthquake consequences. It is simply an educational task and the

USGS has more people in more communities where they can help stir up interest and action.

Senator ROBB. One final question and then I will ask Senator Ford if he has some questions.

You decided to put the USGS as the lead agency instead of establishing an independent commission. Any thoughts on the relative merits of that particular choice?

Senator CRANSTON. Well, first on commissions, commissions really mean study, not action. And I think we have done enough in that phase. We need more study, but it should be connected with action that would come from the USGS.

The USGS again is a major agency with staff spread around the country, ready to act, knowledgeable, the best trained people. We think placing the major responsibility with the USGS is therefore the wisest way to go.

Senator ROBB. Since you will not be here when others who have a different view of where that responsibility ultimately ought to be lodged will have a chance to testify, do you want to make any comment on the prospect for leaving it where it is?

Senator CRANSTON. Well, I think it would simply be better to place the responsibility in USGS. FEMA has done some fine work, but I think that the Geological Survey simply has greater capacities and capabilities that we need to apply now.

Senator ROBB. Thank you, Senator Cranston.

Senator Ford.

OPENING STATEMENT BY SENATOR FORD

Senator FORD. I will just make a comment or two and then, Senator Cranston, if you want to comment on my statement, please do. There has been serious complaints to me and to others about the lack of coordination and leadership that has been provided in this area.

My information is that there are many different constituencies that will be involved here and that all of them agree that the present funding levels are too low and not providing adequate leadership. I think we have got some real problems.

Sure, people may object to where we might think the leadership should go, but I think any change would be a change for the better at the present time, with the information I have.

As you know, we have some problems, as you mentioned, in west Kentucky and I intend to help as best I can to be sure that we do educate and that we are prepared. States ought to be in the position of being prepared with their emergency operation. It is something that should be given serious consideration by state governments.

So as far as changing leadership, we have had the same leadership for a while and all we get is complaints from those who are concerned. Your surgery is minor to me, but my minor surgery is major to me. So those who are in the area, they need to have some feel that people are out there looking out for their interests and trying to be prepared, and hope it never comes.

Senator CRANSTON. Well, I am glad that you have recognized the need for change and have been thinking about this. It certainly is needed, and you can be very helpful in bringing it about.

Senator FORD. That is all I have, Mr. Chairman.

Senator ROBB. Thank you.

We have been joined by Senator Bryan from Nevada, who has more than a passing interest in this particular topic as well.

Senator BRYAN. Yes.

Senator FORD. You notice the three governors talk about state government.

Senator CRANSTON. You know, they sometimes say that if California falls into the sea with a major quake, that Nevada would then have seaports.

OPENING STATEMENT BY SENATOR BRYAN

Senator BRYAN. As a matter of fact, we have had some entrepreneurs over the years, as you know, Senator, who have sold oceanfront property in Nevada and done quite well.

Senator FORD. Yes, but then Nevada would have water.

Senator BRYAN. Thank you, Mr. Chairman.

I just want to congratulate Senator Cranston and the other co-sponsors. I am glad that you have taken leadership since 1977 and, because I come from a state that has a good bit of seismic activity. Indeed I used to be counsel to the State Board of Architecture in Nevada and we have a special section on the architectural examination that requires you to have performed some seismic work as a condition precedent to be licensed as an architect in Nevada. I can share as a former governor my frustration with the agency that presently has jurisdiction over the program.

I will not say to you that that is the only reason that your bill has merit, but it certainly commends itself to me, and I am going to be happy to support your measure.

Senator CRANSTON. Thank you very much. I am delighted to know of your support. And I know of the concerns that you have to have in Nevada about quakes.

Senator ROBB. Do you have any questions, Senator Bryan?

Senator BRYAN. I do not, Mr. Chairman.

Senator ROBB. Senator Cranston, that would complete the questioning.

It sounds to me, with three former governors, all of whom having had experience in this area in their previous capacities, that you have at least a sympathetic audience to begin the presentation for this bill.

Senator Cranston, we thank you very much.

Senator CRANSTON. Thank you, and thank you for the opportunity. Thank you for conducting the hearing.

Senator ROBB. Thank you, sir.

If the next panel would like to come up and take their places, we will proceed as soon as they are ready.

[Pause.]

Senator ROBB. Gentlemen, thank you for coming. We will go ahead and begin.

Our first panel will discuss the threat that earthquakes pose to the East Coast and the rest of the country, and we will be discussing what can be done to meet that threat. Our witnesses reflect the wide range of people that are interested and involved in the national earthquake program.

Dr. Robert Ketter is the Director of the National Center for Earthquake Engineering Research at the State University of New York at Buffalo. Mr. Lacy Suiter is the Director of the Tennessee Emergency Management Agency and is the recently elected head of the seven-state Central United States Earthquake Consortium.

And Mr. George Bernstein is an attorney who works with the insurance industry on earthquake issues and recently chaired a panel of experts who reviewed the NEHRP program.

In addition to our witnesses, after Dr. Ketter's testimony this morning, we are going to see a short video, which I mentioned a few minutes ago, that shows what could happen to Memphis, Tennessee, if it were struck by a magnitude 8 earthquake similar to the ones that hit Tennessee and that region back in 1811 and 1812.

The videotape shows a computer simulation produced by Mr. Robert Chartrand, a consultant for the Congressional Research Service. Mr. Chartrand could not be here today, but he has kindly allowed us to show the tape.

I think it is important to realize that this scenario does not apply just to Tennessee. Similar scenarios could be developed for any number of regions, particularly highly built-up regions around the country, and I think it will give us some pretty graphic evidence of some of the things that are involved.

Dr. Ketter, if you would be kind enough to lead off, sir.

STATEMENT OF DR. ROBERT L. KETTER, DIRECTOR, NATIONAL CENTER FOR EARTHQUAKE ENGINEERING RESEARCH, STATE UNIVERSITY OF NEW YORK AT BUFFALO

Dr. KETTER. Yes, sir. You asked in the letter that I address three issues—the threat of earthquakes in the central and eastern part of the United States, the efforts of the National Center to mitigate against those threats, and the effectiveness of the NEHRP legislation, and S. 629—and to do all of this within seven minutes. I think that is virtually impossible.

I will in fact, however, spend about six minutes on the first one, skip the second one, and do the third one for about three to four minutes. There are 20-some pages of testimony that have been left.

So if I could proceed with the first——

Senator ROBB. We would be pleased to extend your remarks to whatever extent your additional testimony requires.

Dr. KETTER. Thank you, sir.

In the United States, California's seismic past is well studied and well known. For years scientists have warned of the inevitable Big One, a devastating earthquake measuring between 7 and 8 on the Richter scale. A recently released United States Geological Survey study pinpoints a 60 percent chance for such a quake to occur in southern California within the next 30 years. The same study estimates the San Francisco Bay area faces a 50 percent chance of a similar quake within the same time period.

You will have to turn out the lights, the television lights, out now, and if you will refer to some of the slides.

[Slides shown.]

In 1811 and 1812, the central United States was jolted by a series of earthquakes believed by many to have been greater than 8. The quakes, which were centered in the Mississippi Valley near the town of New Madrid, Missouri, could quite possibly be the largest to ever strike this country.

They are said to have been felt throughout the entire eastern half of the United States and were so powerful that they caused church bells to ring in Boston, over 1,000 miles away.

That particular slide shows the location of all earthquakes that have been recorded in the eastern portion of the United States.

Reports of the New Madrid temblor say that the earth in the Mississippi Valley was observed to roll in waves a few feet in height. Large portions of land were uplifted and others sank.

Existing lakes drained and new ones were created. Even the mighty Mississippi was said to have reversed its flow.

If a similar quake were to occur today, it would result in damage, disruption, casualties, and injuries on a scale never experienced from a natural hazard in the history of this nation.

Still other large earthquakes east of the Rocky Mountains have occurred in Charleston, South Carolina, in 1886, near Boston, Massachusetts, in 1755, off the coast of New York City in 1884, and the Charlevoix region of Quebec, Canada, making all of these areas probable sites for future quakes.

Compounding the earthquake problem east of the Rocky Mountains is the distance over which seismic energy is transmitted, because eastern rocks are older and more dense than our western rocks. Earthquakes in the East can cause damage over much larger areas than in the West.

For example, the damage area for the 1811 New Madrid earthquake, which had a similar magnitude as the San Francisco earthquake of 1906, resulted in an area of similar damage that was 15 times larger.

While undoubtedly there can be found exceptions to this general statement, all of the major earthquakes that have occurred in the eastern and central part of the United States have exhibited precursor activities. With that in mind, consider the fact that over 2,000 earthquakes

were recorded in and around the New Madrid-Memphis area between 1974 and 1983, and they are still being felt today.

Seismic activity also is being recorded in the St. Lawrence River valley, in the New York-Boston area, in South Carolina, Virginia, Tennessee, Utah, and all of these are potential sites for future major seismic events.

The most frequently asked and the least satisfactorily answered question concerning earthquakes is, when will the next major one happen? Unfortunately, seismology cannot now, nor will it be able in the near future to answer that in a deterministic fashion, that is, accurately predict when an earthquake will occur.

A probabilistic assessment, however, is possible, and this has been done for the New Madrid as well as a number of other potentially active sites. Based on those calculations, the probability of a destructive earthquake occurring in a single geographic site in the eastern part of the United States—and I emphasize, a single particular site—within the next 15 to 25 years is relatively low.

However, the probability of one occurring somewhere in the eastern part of the United States before the year 2000 can be considered to be better than 75 to 95 percent. Before the year 2010 it will approach 100 percent certainty.

Johnson and Nava have examined the probability of occurrence of two large earthquakes in the New Madrid-Memphis area for two separate time periods, by the end of this century and by the year 2035. The earthquakes that they considered were presumed to have surface wave magnitudes of 6.3 and 8.3 on the Richter scale, the latter one of these corresponding to one of the earthquakes that occurred in 1811.

It was found that the probability of occurrence between now and the year 2000 for the 6.3 earthquake would be between 40 and 60 percent. For the larger earthquake, it would be only three-tenths of one percent to one percent.

However, by the year 2035 there would be an 86 to 97 percent probability of occurrence for the 6.3 earthquake and a 2.7 to 4 percent probability of occurrence for the larger.

This is a generalized isoseismal map for the larger of the two postulated New Madrid-Memphis earthquakes. Shown are the intensities of shaking that would be experienced. The Roman numerals are Modified Mercalli Intensity values and indicate the perceived amount of shaking that would occur.

For example, for an intensity of Roman numeral VI, that is for Chicago, Pittsburgh, Knoxville, and so forth, the shaking would be felt by everyone. Many people would be frightened. Dishes, glassware, and some windows would be broken. Churches and school bells would ring, and the trees and bushes would shake visibly.

In region VIII, that is for St. Louis, Carbondale, Nashville, there would be general fright and signs of panic. Some masonry walls would fall and frame houses, if not securely bolted down, would move on their foundations. Branches would break on trees and cracks would appear in wet soils and on steep slopes.

In the general vicinity of the epicenter, where the intensity has been projected to be a Roman numeral X as shown on the slide, that is for Memphis, most masonry and frame structures would be destroyed with their foundations and there would be large landslides.

Railroad tracks would bend, highway bridges would be unseated, and roads would be closed as a consequence. Should the postulated event occur at night when most people are in their homes, which are primarily wooden in construction, it is estimated that in the six cities near the event, Memphis, Paducah, Carbondale, Evansville, Poplar Bluff, and Little Rock, those six cities, there would result 676 deaths due to structural failures alone.

However, if the event occurred during the day——

Senator DANFORTH. Doctor, is this at 6.3 you are talking about?

Dr. KETTER. This is at an 8.3.

Senator DANFORTH. 8.3.

Dr. KETTER. If the event occurred during the daylight hours, the numbers would increase to 4,907.

Damage to transportation systems would seriously hamper rescue and relief efforts. Railway networks would be similarly affected. River ports would be extensively disrupted, and there would be partial or limited availability of airport facilities. These six cities would experience serious impairment or loss of their utility systems—electrical, water, gas, and sewers.

Were the earthquake to occur at a time when high water conditions existed, flooding of low-lying areas would take place. Widespread individual or small group structural fires would occur, but it is unlikely that there would result giant fires or conflagrations.

For this six-city region of major impact, 460,000 persons would require shelter due to damaged residences. Finally, it is estimated that restoration and replacement costs would exceed $51 billion.

All of the consequences thus far described are so-called "local' consequences. Equally of national importance would be the consequences felt by areas remote to the site. For example, if the epicenter were located in the vicinity of one of the major pipeline routes or if that route passed through an area where major soil liquefaction took place it is likely that an earthquake would disrupt the distribution of flow of transport crude oil and natural gas. Not only would there be potential for serious environmental contamination, but it would be reasonable to expect significant energy outages to heavily populated areas located hundreds of miles away.

It is to be understood that for the purposes of illustration it has been postulated that there would occur a major disruptive earthquake in the Memphis, Tennessee, area. While that area is a reasonable one for such postulation, as I indicated before, we could equally well have chosen other locations for the epicentral site and there would have been similar scenarios, but of different magnitude.

Now, I will skip and go to my prepared statement with regard to the NEHRP legislation—the original and the proposed bill, S. 629, if I might.

Senator ROBB. Please.

Dr. KETTER. The first year budget to establish and maintain the program defined in the Act was $55 million. In terms of real dollars, funding for the program has declined over the years to approximately 60 percent of that originally specified.

This is in spite of the fact that the research and other work conducted have significantly increased our knowledge about earthquake processes, frequency of earthquake occurrence, ground motion, faulting mechanisms, ground failures, and the effects of these phenomena on man-made facilities.

Research has led to advances in design and construction of facilities, and overall improvements in earthquake hazard reduction techniques. Not discounting or minimizing these advances, a great deal more is needed if we are to achieve reasonable levels of earthquake protection that will probably be expected (demanded) by society, in terms of protection of life and property.

These activities encompass both basic and applied research, as well as implementation. Implementation is a required part of the Earthquake Hazards Reduction Act. It is not an alternative to research; it is part of the same continuum.

For implementation, there must be established not only the educational and research base for risk assessment; there must be planning and decisionmaking for preparedness, mitigation, response, and recovery. And that planning must be translated into action programs.

Major implementation costs for earthquake hazard reduction, possibly the major cost, is for education. When each participant actively affecting seismic safety understands the problem and how it should be treated, seismic safety can be achieved with little extra cost, with the exception of assessing and abating of excessive existing hazards.

Enhanced public awareness of the risks that exist is equally of importance. I served on the so-called Expert Review Committee that made recommendations for the five-year plan for NEHRP. We debated at length what had been accomplished and what remained to be done.

Obvious and not so obvious impediments to carrying out a much more aggressive program were discussed. It was agreed by all that the major difficulty had to do with the availability of adequate funding.

True, a significant amount of time of the committee was spent on the lead agency role, and a recommendation was made, again unanimously, by the committee that there be given serious consideration to the establishment of a new Federal earthquake oversight commission, one solely responsible for exercising the NEHRP leadership role currently assigned to FEMA.

I apologize for preempting part of Mr. Burnstein's statement.

I must be honest with you, however. I do not feel that there were many on the committee who felt that this was a politically feasible possibility. We did want, however, to indicate that there needs to be introduced into this discussion other leadership possibilities.

The first among equals concept that has been operative since 1981, where FEMA was designated as the lead agency and in S. 629 currently being proposed by Senator Cranston with USGS as the lead agency, is a concept that works only if there is a strong and aggressive determination on the part of the lead agency to fight for and defend the financial and other needs of all of the agencies involved in the program.

The original 1977 legislation clearly recognized the strengths and mandates of the four designated principal agencies. It is my view that it rightly demurred in defining a management role for any one of the agencies over the programs of another.

Cooperation and collaboration, when budgets are expanding, is comparatively easy to accommodate. When budgets are constant or shrinking, however, this is extremely difficult.

It is my view that, while Senator Cranston has focused on one of the recommendations that was made by the Expert Review Committee, he has not adequately addressed the real problem at issue, that is the real level of funding required for an effective NEHRP program.

My second concern is that, independent of whether the leadership role is continue in FEMA, or is placed in USGS, which is being proposed, or for that matter in any other agency or commission, it will be successful only if and when there is high level aggressive advocacy of the urgent need of all of the programs contained within the NEHRP program.

In times of fiscal constraint, it is necessary to establish priorities, and NEHRP should be no exception to that rule. I would urge caution, however, in presuming that we now have all of the research knowledge that we need and that all that remains is to get on with the job of implementation. Nothing could be further from the truth.

I would be pleased to supply additional information should you wish.

[The statement follows:]

STATEMENT OF
DR. ROBERT L. KETTER, DIRECTOR
NATIONAL CENTER FOR EARTHQUAKE ENGINEERING RESEARCH

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

In your letter of March 23rd, you asked that I address three issues: a) The threat that earthquakes pose to the Central and Eastern United States, b) The efforts that the National Center for Earthquake Engineering Research is making to reduce that threat, and c) The effectiveness of the National Earthquake Hazards Reduction Program and Bill S.629. As you know, I am currently the Director of the National Center for Earthquake Engineering Research at State University of New York at Buffalo, and was a member of the Expert Review Committee convened by the Federal Emergency Management Agency, the National Bureau of Standards, the National Science Foundation, and the United States Geological Survey to make recommendations concerning the next five-year plan (1989-1993) for the National Earthquake Hazards Reduction Program.

I

The Threat of Earthquakes in the Central and Eastern United States

Four months ago, in Armenia, rescue workers searched for survivors under tons of concrete rubble that had once stood as buildings. Schools, factories, hospitals, apartment buildings -- many were heavily occupied at 11:41 AM when the earthquake struck. Within seconds, the majority were gone, collapsed by a tremor measuring 6.9 on the Richter scale.

As sympathy and assistance poured out to Armenian people, many in the United States could not help but consider their own potential vulnerability. The obvious questions were asked. Are parts of the United States at risk to similar devastations? And, if so, what can be done to minimize the damaging effects of earthquakes?

Most scientists agree that there is a better than 50% chance that a severe earthquake will strike somewhere within the United States, within the next 30 years. Exactly where and when this temblor will occur is not known. What is know is this -- many regions of the United States have been victim to large earthquakes in the past. And, although earthquakes have been known to occur

in so called "quiet zones," areas not believed to be of seismic risk, a strong belief among seismologists is that earthquakes are likely to happen again where they have happened before.

In the United States, California's seismic past is well studied and well known. For years, scientists have warned of the inevitable "big one" -- a devastating earthquake measuring between 7 and 8 on the Richter scale, that is sure to strike along or near California's famed San Andreas fault. A recently-released United States Geological Survey study pinpoints a 60% chance for such a quake to occur in southern California within the next 30 years. The same study estimates that the San Francisco Bay area faces a 50% chance of a similar quake within the same time period.

San Francisco, of course, is the site of the nation's most devastating earthquake. It occurred in April of 1906, and measured an estimated 8.3 on the Richter scale. The tremor ruptured 270 miles of the San Andreas fault. The entire City of San Francisco was destroyed -- mostly due to earthquake-induced fires. Approximately 700 people were killed. The Federal Emergency Management Agency estimates that a similar event today would claim 3,000 to 11,000 lives, cause 12,000 to 44,000 additional serious injuries, and result in $25 billion in property damage.

In 1964, another major quake shook beneath the ocean, just off the coast of Alaska. Known as the Good Friday earthquake, the tremor measured 8.4 on the Richter scale. The force of the shaking was so intense that it caused tsunamis (large tidal waves) to strike many coastal cities, some thousands of miles away. Anchorage suffered severe damage, and much of this was caused by earthquake-induced mud-slides.

In 1811 and 1812, the Central United States was jolted by a series of earthquakes believed by many to have been greater than magnitude 8. The quakes which were centered in the Mississippi Valley near the Town of New Madrid, Missouri, could quite possibly be the largest to ever strike this country. They were said to have been felt throughout the entire eastern half of the

United States, and were so powerful that they caused church bells to ring in Boston, over 1000 miles away.

Reports on the temblors say that the earth in the Mississippi Valley was observed to "roll" in waves a few feet in height. Large portions of land were uplifted and others sank. Existing lakes drained and new ones were created. Even the Mighty Mississippi was said to have reversed its flow. If a similar quake were to occur today, it would result in "damages, disruptions, casualties and injuries on a scale never experienced from a natural hazard in the history of this nation."

Still other large earthquakes east of the Rocky Mountains have occurred: in Charleston, South Carolina (1886); near Boston, Massachusetts (1755); off the coast of New York City (1884); and in the Charlevoix region of Quebec, Canada --making all of these areas probably sites for future rattlers.

Compounding the earthquake problem east of the Rocky Mountains, is the distance over which seismic energy is transmitted. Because eastern rocks are older and more dense than are western rocks, earthquakes in the east can cause damage over much larger areas than in the west. For example, the damage area for the 1811 New Madrid earthquake, which had a similar magnitude as the San Francisco earthquake of 1906, resulted in an area of similar damage that was 15 times larger.

While undoubtedly there can be found exceptions to this general statement -- all of the major earthquakes that have occurred in the eastern and central part of the United States have exhibited precursor activities. With that in mind, consider the fact that over 2000 earthquakes were recorded in and around the New Madrid-Memphis area between 1974 and 1983 -- and they are still being felt today.

Seismic activity is also being recorded in the St. Lawrence River area, in the New York-Boston area, in South Carolina, Virginia, Tennessee and in Utah. All of these are potential sites for future major seismic events.

April 7, 1989

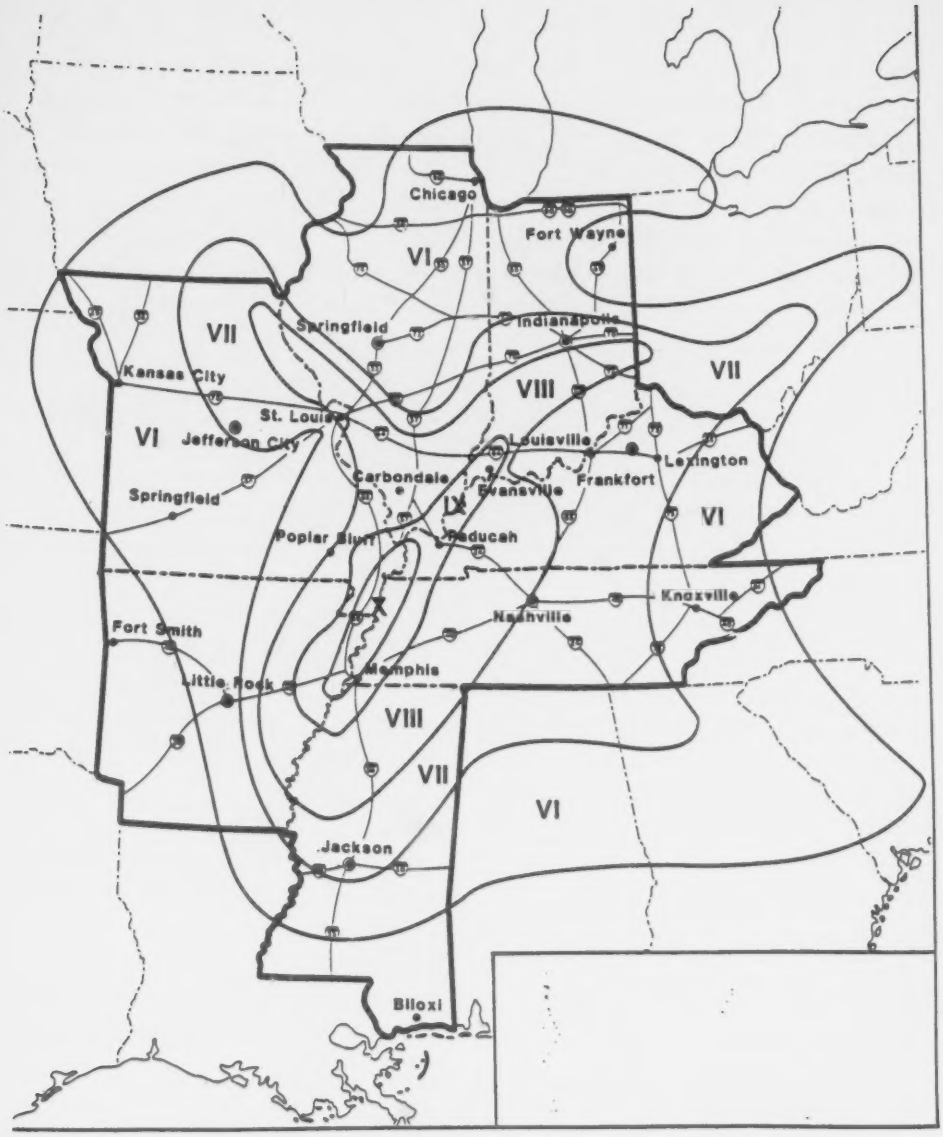
The most frequently asked, and the least satisfactorily answered question concerning earthquakes is "when will the next major one happen?" Unfortunately, seismology cannot now, nor will it be able in the near future to answer that in a deterministic fashion; that is, accurately predict when an earthquake will occur. A probabilistic assessment, however, is possible, and this has been done for the New Madrid as well as a number of other potential active sites. Based on those calculations, the probability of a destructive earthquake occurring at a single geographic site in the eastern part of the United States within the next 15 to 25 years is relatively low. However, the probability of one occurring somewhere in the eastern United States before the year 2000 can be considered better than 75 to 95%. Before the year 2010, nearly 100%.

Johnson and Nava have estimated the probability of occurrence of two large earthquakes in the New Madrid-Memphis area for two separate time periods--by the end of this century, and by the year 2035. The earthquakes they considered were presumed to have surface-wave magnitudes of 6.3 and 8.3 on the Richter scale, the latter corresponding to one of the 1811 quakes. It was found that the probability of occurrence between now and the year 2000 for the smaller quake would be 40 to 60% probability; for the larger, 0.3% to 1%. By the year 2035, there would be an 86 to 97% probability of occurrence for the smaller one, and 2.7% to 4% probability of occurrence for the larger.

Figure (1)

This is a generalized isoseismal map for the larger of the two postulated New Madrid-Memphis earthquakes. Shown are the intensities of shaking that would be experienced.

The Roman numerals are Modified Mercalli Intensity values, and indicate the perceived amount of shaking that will occur. For example, for an intensity of VI; that is, for Chicago, Pittsburgh, Knoxville, etc.; the shaking would be felt by everyone. Many people would be frightened; dishes, glassware and some windows would be broken; church and school bells would ring; and trees and bushes would


Chicago
Fort Wayne
VI
Springfield
Indianapolis
VII
VII
Kansas City
VIII
St. Louis
VI
Jefferson City
Louisville
Lexington
Carbondale
Evansville
Frankfort
Springfield
IX
VI
Poplar Bluff
Paducah
Knoxville
Nashville
Fort Smith
Memphis
Little Rock
VIII
VII
VI
Jackson
Biloxi

24-223 0 - 90 - 2

shake visibly. In region VIII; that is, for St. Louis, Carbondale, and Nashville; there would be general fright and signs of panic; some masonry walls would fall and frame-houses, if not securely bolted down, would move on their foundations; branches would break on trees, and cracks would appear in wet soil and on steep slopes. In the general vicinity of the epicenter, where the intensity has been projected to be X; that is, in Memphis; most masonry and frame structures would be destroyed with their foundations; there would be large landslides. Railroad tracks would be bent. Highway bridge spans will be unseated and roads closed as a consequence.

Should the postulated event occur at night, when most people are in their homes -- which are primarily of wooden construction -- it is estimated that in the six cities nearest to the event -- Memphis, Paducah, Carbondale, Evansville, Popular Bluff, and Little Rock -- there would result 676 deaths due to structural failure. If the event occurred during the daylight hours, that number would increase to 4907 deaths.

Damage to transportation systems would seriously hamper rescue and relief efforts. Railway networks would be similarly affected. Riverports would be extensively disrupted, and there would be partial or limited availability of major airport facilities. These six cities would experience serious impairment or loss of their utility systems (electric, water, gas, and sewers).

Were the earthquake to occur at a time when highwater conditions existed, flooding of low-lying areas would take place. Widespread individual or small-group structural fires would occur, but it is unlikely that there would result giant fires, or conflagrations. For this six city region of major impact, four hundred and sixty thousand (460,000) persons would require shelter due to damaged residences. Finally, it is estimated that restoration and replacement costs would exceed $51 billion.

All of the consequences thus far described are "local" consequences. Equally of national importance would be the consequences felt by areas remote to the site. For example, if the epicenter were located in the vicinity of one of the major

pipeline routes, or if that route passed through an area where major soil liquefaction took place, it is likely that such an earthquake will disrupt the distribution of flow on transport crude oil and natural gas. Not only would there be the potential for serious environmental contaminations, but it would be reasonable to expect significant energy distribution outages to heavily populated areas located hundreds of miles away.

It is to be understood that for the purposes of illustration it has been postulated that there will occur a major disruptive earthquake in the Memphis, Tennessee area. While that area is a reasonable one for such postulation, we could equally well have chosen other locations for the epicentral site.

For a long time, most people have viewed earthquakes as only a "California" problem. What history has shown, of course, is that earthquakes are a national problem, and they need to be given greater consideration in other parts of the country. This is especially true in areas east of the Rocky Mountains, where lack of preparedness and planning leaves people vulnerable to inevitable disaster.

This false sense of security is easily explained. While large earthquakes have historically occurred in many parts of the United States, they occur infrequently outside of California and Alaska. Eastern United States' earthquake recurrence rates are typically measured in hundreds, and possibly thousands of years. Therefore, large numbers of people living in the United States today, especially those living in the east, have never felt an earthquake. Furthermore, they do not ever recall hearing about one from parents or grandparents. Because of this, complacency has set in, and earthquakes and earthquake preparedness are given little attention by the public at large, emergency response agencies or building code and public officials.

On November 25, 1988, the day after Thanksgiving, a temblor measuring 6.0 on the Richter scale rumbled through Quebec, Canada. Within minutes, the quakes sent shivers throughout the eastern United States from Maine to Michigan, and as far south as Washington, D.C. Fortunately, it caused little damage.

However, for many people, this was their first earthquake experience. And many were shaken with the thought that earthquakes can happen in that part of the country as well.

Earthquakes strike without warning making them the most potentially crippling of all natural disasters. Due to this spontaneity, researchers argue that the time for preparedness is now.

In 1977, the federal government established the National Earthquake Hazards Reduction Program (NEHRP), which calls for cooperation of the scientific research community, federal agencies, private industry and for international cooperative research and testing -- the program focusing on efforts to minimize earthquake risk throughout the United States. Addressed within that program are a number of issues important to better earthquake safety. Among the most significant of these are increasing research, improving building codes and construction standards and practices, improving emergency response, and the importance of public information and participation in order to reduce earthquake risks.

IMPROVING CONSTRUCTION

The Armenian earthquake is evidence that earthquakes don't kill people, collapsing buildings do. To protect lives during an earthquake, buildings initially must be designed and built to resist earthquake forces. Outside of California and Massachusetts -- and later this spring, Connecticut -- no other state governments have addressed the issue of seismic design and building codes, thereby subjecting populations, especially in large urban areas, to significant hazards.

Of greatest concern is the construction of critical facilities like hospitals, and fire and police stations. Following a severe earthquake, the services provided through these facilities become increasingly important. Should the buildings not survive the earthquake themselves, they are no help to those in need of emergency medical assistance, compounding an already serious problem. (In

Armenia, injured earthquake victims had to be transported long distances for initial medical attention, causing great hardship, and minimizing the chances for survival of the critically injured.)

Additionally, structures like schools, factories, office buildings, and apartment buildings, pose a threat to large numbers of people who occupy these structures. A major reason for the enormous loss of life in Armenia was the fact that these types of buildings were heavily occupied at 11:41 AM when the earthquake struck. Similar tragic results are possible in the United States, especially in the central and eastern portions of the country, if existing building structures are not upgraded, and new buildings continue to be built with little or no seismic resistance.

IMPROVING EMERGENCY RESPONSE

When an earthquake strikes causing buildings to collapse on people, immediate emergency response is almost inherent to the rescue of trapped victims many of whom may be severely injured. Studies from previous destructive earthquakes have shown that immediacy of emergency response has a direct effect on mortality rates. People trapped for less than 24 hours have a much greater chance of survival than those who are rescued afterwards, thus emphasizing a need for improved emergency response.

Also, following a severe earthquake, rescue workers are often confronted with unique situations never before experienced. Only through better planning and training, including earthquake disaster drills, can emergency response teams improve their performance in the field.

PUBLIC INFORMATION

With complacency being a major hurdle to earthquake readiness, a great deal of significance is placed on the importance of public information to educate people at all levels. Better earthquake education can lead to better earthquake

preparedness in the home, school, in offices, among emergency personnel at critical facilities, and among building code officials.

Only a concentrated and continued flow of information about earthquakes will raise the consciousness of people throughout the country to the level required to bring about changes; changes in building codes to ensure safer more earthquake-resistant built environments, changes in emergency response training to include earthquake preparedness drills, and changes in earthquake preparedness levels in homes, schools, businesses, etc.

History and research have proven that earthquakes are not just a California problem. Unless and until serious steps are taken to counter an earthquake's destructive powers, we are vulnerable to devastation similar to that felt in Armenia. The eastern and central portions of the United States are not immune!

II

The National Center for Earthquake Engineering Research

The National Center for Earthquake Engineering Research was established at State University of New York at Buffalo in September of 1986 by the National Science Foundation. It is, therefore, two and one-half years old. Even at this early stage, one can point to a number of successes:

- Setting up a working and well functioning administrative structure,
- Developing a method of funding that relies on organized group efforts,
- Generating substantial amounts of matching funds, and thereby greatly increasing the research support for earthquake engineering,
- Defining critical areas of research,
- Developing cooperation among groups of researchers from different institutions, and from different disciplines,
- Establishing connections with practicing engineers and industry,
- Gaining (rather quickly) a positive reputation among the public and the technical community,

- Achieving great visibility, particularly in the eastern and central parts of the United States, thereby increasing awareness of the seismic risk,
- Engaging many young researchers in earthquake engineering research,
- Publishing a large number of technical reports and journal articles,
- Financing major upgrades at core experimental facilities,
- Organizing workshops, conferences, and forums, and holding of numerous television, radio and other media conferences,
- Creating an on-line earthquake engineering information system, and
- Establishing working relationships, and formal cooperative agreements with peer organizations and institutions in a number of different foreign countries.

Over the first two years, the $5 million per year provided by the National Science Foundation has been leveraged at a rate of approximately 1.7; that is, for the $10 million, there has been raised an additional $16,956,000 in non-federal matching support.

A particularly significant development has been the establishment of NCEER Information Service, which is available via computer link to all researchers, professionals, libraries, government offices, etc. throughout the world. As part of that service is an Information Service data base, Quakeline. It contains a large number of indices and abstracts of published information which are generally not indexed through any other source.

NCEER has published, during the past two-years, seventy-two Technical Reports resulting from its various research projects. An additional thirty-nine are currently in review, or are being prepared.

To date 114 principal investigators throughout the United States have been involved in the research program. Thirty U.S. institutions have been involved. There have been 24 industrial "participants."

The Center has entered into formal Agreements or Memoranda of Understanding with a number of foreign countries and/or research institutes: five in Japan,

three in China, one in Taiwan, one in Spain, one in Austria, one in Mexico, and one in Greece. A number of other requests for cooperative and collaborative research are currently being considered. These involve researchers in Chile, Great Britain, France, Yugoslavia, Turkey, and India.

LETTERS OF SUPPORT

You might be interested in comments contained in a letter recently received from Dr. T.P. Tassios of the National Technical University of Greece:

> 'Now that we have finalised the Draft Euro-Code Nr 8 ("Aseismic Design of Structures"), we wish to express our gratitude to those who have directly or indirectly contributed to this long exercise. ... Several of your "Technical Reports" have been very profitably used by our Working Groups when drafting the relevant Parts of this European Code. We have repeatedly felt that your long list of some 60 publications during the last two years were a very important source of support and inspiration for our work. ... '

Or, you might be interested in the following from the Assistant Chief of the San Francisco Fire Department, Mr. Frank T. Blackburn:

> "I participated in the recent workshop on Serviceability of Water Delivery Systems on December 1 and 2 ... . The Workshop was very informative to those of us on the practical operating side of the aftermath of earthquakes and how they affect urban areas.
>
> "Cornell University was instrumental in greatly assisting our Department and the City of San Francisco in upgrading our emergency water supply and delivery systems. The Engineering Department had published a report on our two water systems and this excellent report formed the basis for the successful 1986 Fire Protection Bond Issue, a $46.2 million issue that was passed by the voters with 89.2% of the vote. ...
>
> "I would like to compliment the National Center for Earthquake Engineering Research for sponsoring research on lifeline systems. This type of research

greatly contributes to a safer, more cost efficient water delivery system for San Francisco. ... "

Or, from Peter I. Yanev, Chairman of EQE Engineering in San Francisco:

"The Center has served as the agent of diversification of earthquake issues from California to all areas of the U.S. that have seismic hazards. The recent Armenia earthquake (which occurred in a region with seismicity like that of parts of the U.S. outside California) is a poignant example that this is the right direction to follow. Several regions of the U.S. , including Salt Lake City, the New Madrid region, Puget Sound and Charleston, S.C., can experience comparable disasters. Whereas California is beginning the process of resolving its earthquake problems, the rest of the nation lags far behind. From that perspective, I see NCEER providing invaluable leadership, and providing it well. We are beginning to see progress, and regional recognition of the extent of the earthquake hazard in the U.S. outside California. This progress is greatly aided by leveraging of research resources to all parts of the nation, which a National Center permits. Much of the credit goes to the Center, its committees and staff."

Or, from Nils V. Ericson, P.E., of Di Salvo Associates Consulting Engineers of Ridgefield, Connecticut:

"I am writing to thank you and NCEER for the efforts of two of your members in our search for seismic background to address an issue with state wide impact. We, as structural engineers and members of the Structural Engineers Coalition of the Connecticut Engineers in Private Practice, have recently considered our position on the State of Connecticut's proposal to adopt the 1987 BOCA Code and its Zone 2 earthquake design provisions for buildings.

"Dr. Klaus Jacob and Professor Peter Gergely have been an invaluable resource of seismic information and earthquake design details. Their presentations at a January conference of our members and the State Building Inspector provided us with the scientific facts necessary to

appreciate the probability of a seismic event and the risk to public safety in our state.

"Subsequently, we elected an affirming position on the earthquake code. Last month I testified at the public hearing on the code adoption and voiced our support. The code is scheduled to be adopted this July and will mark the start of building earthquake design in the state."

Or the remarks of Walter W. Hays, Deputy for Research Applications, Office of Earthquakes, Volcanoes, and Engineering of the United States Geological Survey of the Department of Interior:

"As you know, we have just completed, on behalf of the four principal agencies, a comprehensive review of the accomplishments during the first decade of the NEHRP that have contributed to earthquake hazard mitigation. In the context of this review which involved more than 100 participants over a 1-1/2 year period, it seems clear to me that:

"o the goals of the NEHRP would likely have been realized more fully if NCEER had existed in 1977, the YEAR the NEHRP began.

"o The comprehensive goals of the NCEER which encompass both research and implementation activities are perfectly matched with the current goals of the NEHRP. Also, the accomplishments of NCEER during the first three years have met important needs, especially in the Eastern United States, that would not otherwise have been met.

"o NCEER is in a unique position to contribute to the urgent needs of the Nation for increased earthquake hazard mitigation during the second decade of the NEHRP.

"I am looking forward to working with you during the second decade of the NEHRP just to see the exciting research and implementation on activities that you will successfully accomplish."

April 7, 1989

EXAMPLES OF CENTER ACTIVITIES IMPORTANT TO
THE CENTRAL AND EASTERN PARTS OF THE COUNTRY

a) A major achievement of NCEER during these first two and one-half years has been the timely instrumenting of portions of eastern and central United States with about a dozen modern digital strong-motion recorders. In the short period since their installation, they have already provided more digital strong-motion data than ever before collected for this part of the nation. From these data, especially those generated by the M=6 Saguenay earthquake of November 25, 1988, in Quebec, Canada, it was possible to derive the first ground motion attenuation relationship for eastern North America which is actually based on strong instead of weak ground motion recordings. These results will almost certainly modified the ground motion relationship to be used in preparing the new generation of seismic hazard maps for the eastern U.S.

b) Also, an entirely novel approach was taken to create a strong-motion data base. It can accept a variety of other geographically based data (rather than site-specific) required for regionalized risk and damage assessments. The system is novel in that it is a graphically oriented, interactive data base, which contains a searchable parametric data file in a regional configuration, and the actual data themselves (that is, accelerograms, response spectra, geotechnical borehole logs, earthquake intensity files, earthquake catalogues, etc.) are on-line, and do not require mounting of tapes, disks, etc. When fully operational (planned for the summer of 1989), the data base will be interrogable remotely via phone or computer networks.

c) As part of NCEER's efforts in strong-motion instrumentation and establishing the data base, a special effort was mounted to bring together complete information on all strong-motion stations east of the Rockies. This involves several dozen operators of such equipment including the USGS, Corps of Engineers, TVA, DOE facilities, universities, Veterans Hospital Administration, and many others. This new catalogue will be released in 1989, and will serve the purpose of making future strong-motion

data collected by all of these facilities more readily available to the user community. This new catalogue for the U.S. east of the Rockies can also provide the input to merging efforts by EERI to foster a national inventory of all existing strong-motion operation efforts.

d) All of these and other investigations have been carried out to prepare for a new generation of hazards maps to be used in conjunction with existing or future updated building codes. A dialogue between NCEER, EPRI, USGS, GSC and other organizations involving defining the seismic hazards in eastern and central North America, and usage in new generation of building codes, has been initiated. This issue will be a future challenge for many organizations.

e) Conclusive new evidence of extensive soil-liquefaction has been unearthed for sites in the northeastern U.S. (Massachusetts, New York, Canada). Many of the northeastern liquefaction cases were caused by earthquakes as small as M=5 to 6, which -- based on western U.S. experience -- were generally thought of being incapable to cause significant liquefaction. It was also observed that these same sites are generally likely to be prone to strong site amplifications.

The ultimate purposes of these NCEER efforts are to develop a strategy and a methodology to systematically incorporate specific site conditions into the engineering and design of regular structures, and, in a specified form, to have them available for consideration in future building codes and urban planning efforts. The results are crucial to compute realistic damage estimates for likely earthquake scenarios in existing urban settings.

f) Active control is an emerging technology which holds promise in protecting structures from possible severe damage due to seismic forces. A major thrust of the NCEER research work in this area is the experimental verification of active control strategies under realistic conditions. It represents a major step in bringing this technology from the conceptual to the implementation phase. The results of this research are directly

responsible for the design of two active protective systems to be incorporated into two tall buildings in Japan.

g) NCEER has undertaken substantial work in evaluating the seismic behavior of existing and new buildings, with emphasis on those types which predominate in central and eastern United States; lightly reinforced concrete structures, and steel frame structures containing semi-rigid connections. These studies are of particular significance to design engineers, code writers and implementors. Full and reduced scale models have been tested using static, earthquake, and pseudodynamic loadings, with application of analytical modeling and verification techniques. Research results have provided improved capabilities for seismic hazard assessment and mitigation in low and medium-rise buildings.

h) ATC-14, "Evaluating the Seismic Resistance of Existing Buildings", was written to apply nationwide, although the emphasis was placed on buildings in regions of high seismicity. Over the last year or so NCEER has had carried out a major study to determine their applicability in regions of low or moderate seismicity, such as would be found in the central and eastern portions of the country. There has resulted a large volume of proposed modifications and additions. Unfortunately, FEMA does not wish to revise ATC-14 to include these additions. NCEER will, therefore, publish and make available the document in question.

i) Water delivery systems are complex in terms of operational, functional, topographical and mechanical characteristics, as well as from the viewpoint of societal impact in case of their failure. Research is needed to improve and upgrade the state-of-the-art of evaluating the systems' seismic performance, particularly from the viewpoint of serviceability performance for post-earthquake fire-fighting. One of NCEER's major research objectives in this area is the development of practical methods or determining the seismic vulnerability of lifeline systems. The results of these studies will be extremely useful for managers and engineers of water and fire departments, and will help them to develop not only operational

plans in case of seismic emergencies, but also future programs for upgrading systems.

Though it was originally designed for San Francisco's auxiliary water supply system, computer programs developed under NCEER sponsorship for system serviceability analysis, such as those developed at Cornell University with its interactive computer colorgraphics capability, are transferable for practical use by water distribution managers and engineers at large. Work on the water system for the City of Memphis is underway.

j) The overall objective of NCEER research on crude oil transmission systems (which primarily covers the Gulf of Mexico area through the northeastern United States) is to perform seismic vulnerability analysis of the system (or at least some of its subsystems), and estimate the risk arising from its physical and/or functional failure. At this time, the primary risk is perceived as resulting from disruption of oil supplies for military and civilian use, and environmental pollution due to oil leakage.

k) How can the loss of life and injury in the next major event be minimized? This is the aim of NCEER's research in the general area of Earthquake Injury Epidemiology, and Search and Rescue in Collapsed Buildings. The specific mechanisms of death and injury in earthquakes have not yet been the subject of extensive study. In particular, very little is known as to what distinguishes those who will survive from those who will not. Early work by epidemiologists has produced an indication that earthquake fatalities and injuries will benefit from a more disciplined study. Subsequent work by architects and engineers has pointed to the possibility of more rigorous data gathering in the aftermath of major earthquakes.

There is the need for the development of a casualty estimation system for optimization of rescue activities. It must include a number of component elements: building stock characteristics, damage estimation modeling, casualty estimation modeling, rescue operations management modeling, global risk assessment, categorization of urban vulnerability, prediction of collapse

potential, and the perception of the individual. A real time casualty estimate system would represent a major contribution to disaster planning, and this is one of the goals of the NCEER research. It would have a major function as an educational tool, and as an element in risk communication.

l) The development of teaching methods, curricula, and materials for earthquake education are in their early stages. Research related to students' misconceptions in science can guide this development process, and these studies are currently underway.

These are but a few examples of NCEER's work currently underway, which will have a direct impact on reducing the threat that earthquakes pose to the central and eastern United States.

III

National Earthquake Hazards Reduction Program and Bill S.629

The Earthquake Hazards Reduction Act of 1977 (Public Law 95-124 [S.126]), as amended in 1980 (Public Law 96-472 [S.1393]) established for the first time in the United States a national program to coordinate federal efforts to reduce future losses of life and property damage from earthquakes.

The first-year budget to establish and maintain the program defined in the Act was $55 million. In terms of "real dollars," funding for the program has declined over the years to approximately 60% of that originally specified. This is in spite of the fact that the research and other work conducted under the auspices of the Act have significantly increased our knowledge about earthquake processes, frequency of earthquake occurrence, ground motions, faulting mechanisms, ground failures, and the effects of these phenomena on man-made facilities. Research has led to advances in designing and constructing facilities, and overall improvements in earthquake hazard reduction techniques.

Not discounting nor minimizing these advances, a great deal more is needed, if we are to achieve reasonable levels of earthquake protection that will probably be expected (demanded) by society in terms of protection of life and property. These activities encompass both basic and applied research, as well as implementation.

Implementation is a required part of the Earthquake Hazards Reduction Act. It is not an alternative to research. It is part of the same continuum.

For implementation there must be established not only the educational and research base for risk assessment, there must be planning and decision-making for preparedness, mitigation, response, and recovery, and that planning must be translated into action programs.

A major implementation cost for Earthquake Hazards Reduction, possibly the major cost, is for education. When each participant in each activity affecting seismic safety understands the problem, and how it should be treated, seismic safety can be achieved with little extra cost (with the exception of assessment and abatement of excessive existing hazards). Education includes, on the one extreme, the formal education of young people at the primary and secondary levels. At the other end, it involves continuing education of persons in practice (public administration, management, professionals, labor, homeowners, etc.). Well-structured formal educational programs for earthquake scientists, engineers, and planners are an obvious priority concern. Enhanced public awareness of the risk that exists is equally important, and we at NCEER are particularly proud of our accomplishments in this area.

As I indicated at the outset of this testimony, I served on the so-called Expert Review Committee that made recommendations for the five-year plan for NEHRP (1989-1993). We debated, at length, what had been accomplished, and what remained to be done. Obvious, and not so obvious impediments to carrying out a more aggressive program were discussed. It was agreed, by all, that the major difficulty had to do with the availability of adequate funding. True, a significant amount of the time of the committee was spent on the "lead agency

role," and a recommendation was made, again unanimously, that there be given serious consideration to the establishment of a new Federal Earthquake Oversight Commission -- one solely responsible for exercising the NEHRP leadership role currently assigned to FEMA. I must be honest with you, however, that I do not feel that there were many on the Committee who felt that this was a politically feasible possibility. We did want to indicate, however, that there needs to be introduced into the discussions other leadership possibilities.

The "first among equals" concept that has been operative since 1981, where FEMA was designated as the lead agency, and S.629 currently being proposed by Senator Cranston, with USGS as the lead agency, is a concept that works only if there is strong and aggressive determination on the part of the lead agency to fight for and defend the financial and other needs of all of the agencies involved in the program. The original 1977 Legislation clearly recognized the strengths and mandates of the four designated principal agencies. It rightly demurred in defining a "management" role for any one of the agencies over the programs of another.

Cooperation and collaboration, when budgets are expanding, is comparatively easy to accommodate. When budgets are constant, or shrinking, this is extremely difficult.

It is my view that while Senator Cranston has focused on one of the recommendations that was made by the Expert Review Committee for the NEHRP program, he has not adequately addressed the real problem at issue -- the level of funding required for an effective NEHRP program.

My second concern is that independent of whether the leadership role is continued in FEMA (where it now stands), or is placed in USGS (as is being proposed), or in any other agency and/or commission, it will be successful only if and when there is high level, aggressive advocacy of the urgent needs of all of the programs contained within the NEHRP Legislation.

April 7, 1989

In times of fiscal constraint, it is necessary to establish priorities, and NEHRP should be no exception to that rule. I would urge caution, however, in presuming that we now have all the research knowledge that we need, and that all that remaining is to get on with the job of implementation. Nothing could be further from the truth.

I thank you very much for this opportunity to give these few brief comments concerning the potential for earthquakes in the central and eastern part of the United States, the role of NCEER in reducing that threat, and my views on proposed Bill S.629. I would be pleased to provide you with any additional material that you feel might be helpful in your deliberations.

Robert L. Ketter, Director
National Center for Earthquake
Engineering Research

Senator ROBB. Thank you very much, Dr. Ketter.

We have been joined by the ranking Member of this committee.

We are going to proceed next to a videotape presentation, but I would like to ask Senator Danforth if, either in his capacity as ranking Member or as one very close to the area which is being designated for demonstration purposes, if he would like to make a statement at this time.

Senator Danforth.

OPENING STATEMENT BY SENATOR DANFORTH

Senator DANFORTH. Mr. Chairman, thank you very much. Well, first let me say, I appreciate your holding this hearing.

I walked into the room as Dr. Ketter had a map of the State of Missouri on the screen describing the effect of the great earthquake of 1811 and the possibilities of another earthquake and what it would do.

We have been warned. We have been told that there is a 100 percent likelihood that by the year 2010 there is going to be a significant earthquake in the eastern part of this country, 100 percent. And we have seen in Armenia what happens when there is a major earthquake.

So we have been told the likelihood and we have seen what has happened. We have been told that, in addition to houses collapsing and people being trapped, communications are disrupted, transportation is disrupted, bridges are down. We have seen the logistical nightmare that was created in Armenia.

The warning has been repeatedly given and is absolutely clear. I might say that I regret that this hearing today is not the media event that we had yesterday, because it should be. Yesterday we were talking about a tragic oil spill. Today we are talking about the likelihood, not the possibility but the likelihood, that something is going to happen during our lifetimes in this country that is going to make that tragic oil spill look like a minor event.

And I wish I could say that we were focused on this. I wish I could say that the country is focused on it. It is not. The people of my state are not. I doubt that the people of Tennessee or Arkansas or the people of South Carolina or the other likely places are. It just seems so remote from reality.

But we should be focused. Now, Congress typically looks at this and says, oh, let us pass a law. So what are we thinking about? Well, where should the jurisdiction be? Should it be in FEMA, should it be in the Geological Survey?

I mean, that is such a classic frolic and detour by the Congress of the United States to be debating who has got jurisdiction. I do not care if the jurisdiction is in the National Board of Tea Tasters.

I think the issue is what are we going to do. Let us suppose that tonight there is a major earthquake along the New Madrid fault. Are we ready? What happens? Who does the governor call?

Who comes in? Where is the equipment to deal with this? Where are the medical personnel? Where are the hospital beds? How are services restored? How are people housed? And on and on.

Where are the answers to these? And maybe there are answers. Maybe FEMA has them. Maybe we have an action plan ready to go into effect. I doubt it. Maybe people can tell me that today.

You know, if an earthquake happens tonight, then what happens? Let us not have a situation like we have in the oil spill, with all the government officials coming in, wringing their hands: Oh, we did not expect this; oh, we never anticipated that this could happen; we never thought that this big a tanker; we only thought little tankers were going to hit reefs, not big tankers. So let us not have that kind of excuse. We have been told.

I wish this were a major media event, and I wish the whole committee were here to hear what you have said, doctor, and what I suppose that the rest of the witnesses will say.

Mr. Chairman, we should legislate and we should legislate quickly. And the legislation should not be whose desk is this stuff going to land on. I mean, maybe that is important. I do not know. It is not to me. Maybe it is important to somebody whose desk it is going to land on.

But somebody has to develop a workable action plan that includes doing whatever is necessary to mitigate the damages before it happens, construction and so on, pre-warning, and whatever else, education as Dr. Ketter says, whatever else has to be done.

But somebody has to devise a specific action plan on what is done, and we are going to have to be ready to go on that, and we are going to have to legislate.

And I appreciate your giving me the time to make that comment.

Senator ROBB. Thank you very much, Senator Danforth. You will be pleased to know that your opening presentation registered a 6.8 on the Richter scale.

I think you have our attention.

Senator DANFORTH. I was trying for the 8.1.

Senator ROBB. I think if you are able to remain with us you will reach that magnitude before we are over. Some of the tremors have reached other states that are not immediately in the epicenter, but are not too far away, including Mississippi with Senator Lott.

Would you like to make a statement and see where you come up on the Richter scale before we proceed with the presentations, Senator Lott?

OPENING STATEMENT BY SENATOR LOTT

Senator LOTT. Well, I had not planned to make one, but I have been inspired by my colleague.

Senator LOTT. Who, when he was naming Tennessee and Missouri and all these other places, forgot Mississippi, which is in the immediate Memphis area.

I just want to say that I am looking forward to hearing the rest of the testimony and seeing the film. I did not realize that being a Member of this committee was going to be so exciting, with Ted Stevens" expressions yesterday and now with Danforth's today. It is really exciting to be here.

On a serious note, I do of course represent Mississippi, an area that has been very much hurricane-prone, with Camille in '69 and then Frederick in the mid-seventies, I guess, and Elena even in the eighties, and they have a devastating impact, I guess sometimes of the magnitude of earthquakes, but perhaps because of the location maybe not even as much as they might have.

And I have to say I felt like that our emergency preparedness was better in 1969 than it was in 1979 and the mid-eighties. I was particularly concerned that FEMA at that time did not allow us to make sufficient use of military resources, that they came in with the attitude, look, what can we do to not have to pay these people the maximum amount that is necessary to do the job.

So I feel like FEMA obviously plays a crucial role, and I would like for us to continue to look at the law that allows FEMA to do this work, how quickly they come in, what can they do, what should be their attitude.

And also, I want to re-emphasize the necessity, the absolute necessity, of making use of the available military resources in the area. I am not just talking about MP's to keep people from looting. I am talking about to go in and help with the actual cleanup.

When you have Seabies or in the case of Memphis you have got Millington Naval Base there with a lot of military personnel that would be more than willing to be involved and help, and if FEMA is arguing over who is going to pay for school buses which could be used to

transport people to the site where cleanup is necessary, we do not need that kind of thing.

So I too am very much interested in this area. I think we should have a clear understanding of who is supposed to do what, and the attitude should be can-do, not what can we get out of, from the Federal government's standpoint. And we ought to have a plan in advance of evacuation routes and everything that needs to be done to be prepared for this type of event.

So I am delighted to be here and look forward to hearing the presentations, and will join my colleague from Missouri in expressing further seismic reaction later on.

Senator ROBB. Thank you, Senator Lott.

I suspect that Mr. Becton in particular has been alerted to some of the questions which may be coming his way in the second panel. The interest in this particular topic has certainly increased in the last few minutes if it was not high enough before.

Now, we are going to see if we can get the attention of additional viewers. Next is something that, Senator Danforth, although it is not a media event as such, is in videotape form.

We have a short video presentation from Mr. Robert Chartrand, who is a consultant from the Congressional Research Service that will track very nicely with what Dr. Ketter has said and with what our final two witnesses in this panel will say. Would you go ahead and show us that at this time, please.

Mr. CHARTRAND. An earthquake registering approximately 8.0 on the Richter scale has hit Memphis, Tennessee. Tremors are spreading across the eastern United States, as shown in the six zones on the map here, through various levels of intensity.

The first shocks were felt in Washington, D.C., Philadelphia, and New York, within two minutes, peaking within four minutes. Vibrations were felt, hanging objects placed in motion, liquids disturbed, standing automobiles rocked, and weak masonry and plaster cracked.

Major cities reporting these and more severe repercussions include St. Louis, Chicago, Birmingham, and Jackson. Initial reports out of the Memphis area from ham radio operators and both radio and TV stations operating on auxiliary power indicate widespread chaos in Memphis. Similar reports come from other urban centers in the lower Midwest and South. Especially hard-hit are cities in the so-called "New Madrid fault area"—Little Rock, Arkansas, Paducah, Kentucky, Carbondale, Illinois, Poplar Bluff, Missouri, and Evansville, Indiana.

Reportedly hardest hit is the greater Memphis area. Overflying commercial airliners report one large bridge over the Mississippi River has collapsed and apparently was bearing a long freight train. Its cars are mingled in the bridge wreckage. Extensive flooding in the Memphis River bend is visible.

The Department of Energy is analyzing reported failure of sections of the interstate pipelines carrying natural gas from the Southwest to North and Northeast terminals, affecting service to the quake region and large customer areas, such as New York and Boston, in the northeastern United States.

Chemical toxic release from two plants in the Memphis area poses an immediate threat to populace in downwind areas.

Officials report all-out efforts by emergency forces—police, fire, medical squads—in the face of great obstacles. Only half of fire facilities are still available, and some police facilities are damaged. Many roads are impassable, hindering vehicle movement to areas of destruction.

The Memphis Beltway, I-240, is largely inoperable and over half of the eleven principal access routes, except U.S. 72 to the east, are interdicted. Over 50 percent of major highway sections are out of service and dozens of overpasses damaged.

Damage to all seven rail systems, including track sections, overpasses, is reported, with no return to operation within at least 48 to 72 hours. All traffic control systems dependent on electricity are useless, and local officials have stationed volunteers at key intersections and other control points.

Casualty reports from surviving hospitals—13 of 25 structures reportedly still are functioning, but with only one-half of beds now available. These, along with improvised medical relief centers, indicate significant loss of life and serious injuries among school children due to collapse of dozens of school buildings.

There is improvised evacuation of critical cases, whenever possible, by med-evac helicopters to hospitals outside immediate the catastrophe zone.

First summaries of the extent of damage indicate that most airport facilities are partially operable, with the exception of two major runways at Memphis International.

The first task is expediting the flow of medical materials, food, and critical personnel into and from the quake zone.

Other damage includes approximately half of the Memphis blood storage facilities being out of service or seriously limited due to structural damage and staff casualties. Two skyscrapers and dozens of minor buildings have collapsed. Scores of minor arteries and side streets are impassable, and three television and radio stations" towers have toppled.

Further damage and casualty reports in Memphis show an estimated 200 deaths and over 8,000 injuries. Especially hard hit are commercial centers, factories, offices and schools.

The number of displaced persons in the six-city quake area now is estimated in preliminary reports to exceed 250,000. Thus we have a scene of unprecedented destruction and chaos that is unfolding.

While damage varies across the region, often affected by patterns of construction and geographic configurations, the overall impact of this monster quake has been horrendous. In the Memphis area alone, flooding along the Mississippi River has displaced thousands of persons. Many buildings originally used for shelters are no longer available due to collapse or serious damage.

This is our scenario.

Senator ROBB. That ought to get everyone's attention.

One of the first people asked to respond would in all likelihood be Mr. Lacy Suiter, who is not only the Director of the Tennessee Emergency Management Agency, but is now the head of the Central United States Earthquake Consortium. Mr. Suiter, we would be very pleased to hear from you, sir.

STATEMENT OF LACY SUITER, DIRECTOR, TENNESSEE EMERGENCY MANAGEMENT AGENCY, AND CHAIRMAN, CENTRAL UNITED STATES EARTHQUAKE CONSORTIUM

Mr. SUITER. Thank you, Senator.

We obviously have supplied testimony in advance for the record. I would like to amend the remarks slightly this morning, though, based on what has been said here and a couple things that have happened.

Senator ROBB. Your remarks will be included and any modifications you would like to make would be most welcome.

Mr. SUITER. Thank you, sir.

We in the Central United States Earthquake Consortium, a seven-state area that includes Missouri, Mississippi, Tennessee, Arkansas, Indiana, Illinois, and Kentucky, we think that this hearing is a fitting conclusion for the first National Earthquake Awareness Week.

It started Monday morning in Memphis, Tennessee, with Senator Gore personally dedicating and cutting the ribbon for the Central United States Earthquake Consortium, or CUSEC, as we know it. That was broadcast live back to at least all seven states and any other state that wanted to receive it through a television hookup network that we had there.

That television network had, we think, a rather substantial audience. It was broadcast in Tennessee, as an example, over the Cable Access Television Network in most cities across Tennessee for about an hour and a half.

The Senator in his comments that he made was particularly striking in the parallels that he drew between the Valdez accident in Alaska and the lack of preparedness and then the lack of ability to be able to respond, mainly because it had not happened yet and it is too big to imagine, and those type things, and how that we must be immediately prepared to be able to respond to these things.

I think the Senator probably moved that program ahead, at least in Tennessee and in the seven-state area, by that one television program that we had there back to the emergency service workers, back to the local officials, who are the ones that in the end are going to have to implement a lot of these activities.

So that opened Monday. And then here in this very room on Wednesday we were joined by Big Bird, and Big Bird helped us—or will help us in the future, in terms of working with the children and getting into the schools and getting the earthquake education processes into the school system, where they understand better as they come up through the process what they might expect in the year 2000.

I think it was a tremendous stroke to start with children. And it was amazing how the children knew the answers to a lot of the questions. It was rather pleasing and surprising to find that out.

And I think probably then today's hearings concluding this will ensure success for this particular program. As a matter of fact, the objectives of amending the law may already have been achieved in terms of raising the visibility of the program certainly out in the area.

Perhaps more, and I would like to suggest that, perhaps more has been accomplished in the last seven years by the states and the local governments at least than perhaps has been readily visible to all of us here.

I guess I would like to start out by who I am personally in this activity. Number one, I am a person that lives very close—I happen to live in Nashville, but I live in the area that obviously will be affected by these things. So in that sense I am a user or a benefiter of the services and the preparedness and the things that Dr. Ketter and others have done here to get us ready.

I am also the Director of Emergency Management in Tennessee and I report to the Governor, and am responsible to the Governor for making sure that Tennessee state government has its plans in order and has its response mechanisms there, knows how we will interface with the Federal government, all elements of the Federal government, as well as the local governments.

And we have recognized our responsibilities to fund this program, provide state funds to do so. As a matter of fact, most of the funding for the new—all of the funding, for that matter, for the new facility in Memphis, Tennessee, for CUSEC was provided by the State of Tennessee, and the operational costs of that building, to make sure that in the multi-state area we are focused for that. Our state happens to have about 70 percent of our population affected by this particular activity.

And then the fact that I happen to be the Chairman of the Central United States Earthquake Consortium is just testament to the activities of the seven states who are working together. This is my second time to have been Chairman of this particular association, and we think that in the five years that we have been in being that a lot of good activities have been done.

I am also one of those in the early days who was drug into this, into the awareness of this particular program fighting. And I was fighting from the standpoint that this is now my fifth Governor to work for in 25 years in Tennessee and we have got lots of problems. Your good friend Lamar Alexander was Governor.

And we have got lots of problems in terms of hazardous material accidents, many of which would obviously occur in the event of the earthquake, lost people, floods, like your 1985 flood in the Roanoke, Virginia, area, the things that happen every day.

More than 3,000 emergencies happen in Tennessee every year that require a coordinated or comprehensive response by state and local government, the things that occur, not to count the presidential disasters and the other things that occur.

So we are one of those who was drug into it, did not fully understand that we had a major problem there that needed to take place. I think Memphis State University, under Dr. Johnson, the late Dr. Otto Nutley at St. Louis University, others, finally got our attention.

But however, we went through the San Fernando earthquake, or at least when it occurred back in 1971, not realizing this was a problem in the middle part of the United States. But at a meeting in Kansas City back in 1981, 82, and 83, in that time frame, the scientific community finally got the attention of the state and the local governments and the people that have to manage and prepare for the response, mitigate where possible, and direct the recovery operations for governors and for others, finally got our attention.

And just quite frankly, a lot of work has occurred since then, though the Coalinga earthquakes got our attention more. There was a major conference happening on September the 19th, 1985, when the Mexico City earthquake occurred, the National Association for Search and

Rescue, and from that location we flew the first search dogs into the Mexico City area and some overhead teams that went in to help. And then obviously, the Armenian earthquake last December has got our attention a long way.

So I think that governors are perhaps right now, or at least in the seven state area, which I can speak more directly to, have a more keen awareness of their responsibilities, what is happening, and are committing more resources now to that effort than they have in the past.

I am here today because of the likelihood that that earthquake will occur before the year 2000, and all the things that you saw on the screen up here a few moments ago are probably true. We are planning for an earthquake of 7.6 magnitude, which is what the scientific and technical community tell us that we need to do.

The central United States is not as prepared as we speak right now as is the western part of the States. There are certain research projects that we need to make sure that we understand the basis of why we are doing some of these things, such as in construction, awareness, local emergency preparedness, readiness, and things like that; the fragile lifelines in the middle United States that were portrayed up there, that feed the power to the Northeast and gas and things like this.

Also, the complexity of the problem in the United States. At least the California problem is all in one state. We are dealing here with seven states, seven governors, seven legislatures, 14 United States Senators, 149 Congressmen, about 500 cities and other incorporations that are out there, that we have to be responsible for, not to count all the jurisdictions that are included in the process—the disciplines, I mean, that are included in this.

We are fully aware of the recovery efforts that are there, or the cost of the recovery, without me going into the details that I have listed out here.

What should be done? We think, number one, we should develop an earthquake constituency, not only just of government, but of the private sector and the media and others, to help us get the word out.

To improve the management of the NEHRP research process, through dialogue, through lead agency coordination activity or responsibility, holding somebody accountable: This is what I expect done, when I want it done, and certain benchmarks when we can get there, and holding them responsible to get it done.

And then dissemination of the information through recognized or institutionalized associations, such as CUSEC or BAREPP or SCEPP, or the other agencies that are there.

Thirdly, we think the FEMA program should be—integration should be more aggressive, that it should expand the medical role. The medical role will be obviously a very important one.

There are still major problems in terms of urban heavy search and rescue, the building collapses and things of that nature. And then the distribution of the lessons that are learned there.

We think that, obviously, there should be placed more responsibility or recognition of state and local roles in this activity.

The specific recommendations for leadership: centralized management authority, utilizing state and local networks that are there right now through the National Emergency Management Association, all the state directors, the NGA and the others; and to create greater visibility within whatever agency it is in, but presumably within FEMA, that that visibility is created and it is moved to a higher level; and then to continue to support those things that the governors and all of us worked so hard for in terms of creating a comprehensive emergency management procedure to get that done.

Obviously, to provide the resources that are there, the cost-sharing efforts that are there that we have been talking about to provide the resources to get it done.

And finally, I guess, to forget the turf and worry about who gets the credit for the job, get on with the process of what has to be done, to make sure that schools do not collapse on children, that hospitals—that we do not see that repeated in the United States such as what we saw in Mexico City, and forget about who is going to get the credit for it.

And I think we will find then that we will get a heck of a lot more work done than we have in the past.

And I guess in closing, sir, I would just like to make two points: Number one, for the limited amount of money that the Federal Emergency Management Agency has been allocated over the period of this bill, I think they have been remarkable stewards of that money in terms of better preparedness at the local government level.

We have virtually in most of the seven-state area, those local governments most at risk, we have better planning now than we ever had. We certainly have public awareness plans that are out there for the public and schools and things like that that have been done. And we are working on the mitigation issue.

We have a long way to go, but for a very limited amount of money, which has been continuously tried to be cut over the years, I think in the end the have been remarkable stewards of the money, and many of us who have been in this business for a while understand what happened before that happened.

In the final analysis, I think the lead agency question tends to obscure the most important issue, and that is the need to channel more resources—funding, technical assistance, and relevant research—to the organizations that have ultimate responsibility for implementing the NEHRP.

Thank you, sir.

[The statement follows:]

Statement of Lacy E. Suiter
Chairman, Central U.S. Earthquake Consortium
To
Senate Subcommittee on Science, Technology, and Space
Senator Albert Gore, Jr., Chairman
April 7, 1989 Hearing
National Earthquake Hazards Reduction Program (NEHRP)

Mr. Chairman and Members of the Subcommittee. It is my pleasure to be here today to address the problems, challenges and opportunities associated with the implementation of the National Earthquake Hazard Reduction Program. I will be focusing my remarks on three interrelated areas: first, the nature of the earthquake hazard east of the Rockies, and measures that have been taken in the central U.S. to reduce the hazard; secondly, an assessment of the effectiveness of the NEHRP, with recommendations on steps that can be taken to strengthen the implementation of the program; and finally, I will offer my views on S. 629, introduced by Senator Cranston and co-sponsored by Senators Gore, Hollings and Wilson, which is designed to strengthen the implementation of the NEHRP.

Nature of the Earthquake Hazard in the Central and Eastern United States and Preparedness Efforts Underway.

A combination of factors contribute to an alarming situation in the central and eastern U.S. with respect to the earthquake risk: 1) Increased likelihood of an earthquake east of the Rockies - for example, there is a 40 to 63 percent chance that a magnitude 6.0 earthquake will occur along the New Madrid fault by the year 2000; 2) The fact that a large percentage of buildings in our eastern U.S. cities are 2 to 6 stories high and constructed of unreinforced masonry; 3) The relative fragility of our lifeline systems, such as transportation, water, sewage, electricity systems, and communications, all of which are vital to the functioning of an area; and 4) The lack of experienced, trained personnel, and proper equipment, to carry out a multi-jurisdictional response to a major earthquake that would involve all levels of government and hundreds of "spontaneous volunteers". Finally, the costs associated with the economic recovery from a major earthquake in the central or eastern U.S. are substantial. A 1985 study of Memphis placed the costs of rebuilding

damaged buildings and facilities at over $25 billion in a 7.6 earthquake. The same study also estimated that a magnitude 7.6 earthquake on the New Madrid fault would generate over 10,000 injuries in Memphis alone, primarily from structural failure. Again, the study (Allen and Hoshall, 1985) attributes the high casualty rates to the preponderance of unreinforced masonry construction in the central U.S and the relative absence of seismic provisions in the building codes.

Now for the good news. The earthquake hazard has become recognized in the central and eastern U.S. as a legitimate, credible, and complex problem that needs to be addressed at all levels of government, in cooperation with the research community and the private sector. This progress can be directly attributed to the NEHRP, and specifically the efforts of the Federal Emergency Management Agency (FEMA) and the U.S. Geological Survey (USGS). We can point to success stories in the eastern U.S. in elevating the awareness of the earthquake hazard; and in developing a cadre of expertise in the planning, education, research and engineering fields. However, earthquake preparedness organizations in the central and eastern U.S. have been less successful in translating this awareness into substantive hazard reduction measures. By "substantive" measures I am referring to the incorporation of seismic provisions into building codes for new construction, retrofit programs for existing high hazard structures, and other measures that address a fundamental problem in the eastern U.S.: much of our building stock will not withstand the effects of even a moderate sized (i.e. magnitude 6.0 to 6.5) earthquake. An earthquake in this range could be destructive, particularly if it occurs in the daytime and is centered near a metropolitan area in the central or eastern U.S.

Hazard Reduction Efforts in the Central U.S.

The earthquake hazard reduction programs and strategies that have evolved over the past five years in the central U.S. follow a pattern that is found in other high risk areas east of the Rockies. In view of the fact that the "earthquake problem" was rarely acknowledged outside of scientific circles until about 1982, earthquake programs have essentially started from scratch and typically incorporate the following features: 1) Loss estimation studies that serve as an empirical basis for the earthquake program; 2) Broad based public awareness and education programs, targeted towards a range of groups, that are designed to increase awareness, build

constituencies, and enhance public safety; 3) State and local response plans that are typically developed as annexes to Emergency Operations Plans; and 4) Mitigation activities, including training courses, which to date focus primarily on critical lifeline facilities and systems. The state emergency management agency is the lead agency in the state earthquake programs. FEMA has been the primary federal agency contact for funding, program guidance and other activities related to the NEHRP.

In assessing Tennessee's progress, and that of CUSEC, towards reducing the earthquake hazard and increasing preparedness, I would conclude the following: 1) The greatest progress has been made in raising the level of awareness of the earthquake hazard, and to this end the Allen and Hoshall loss estimation study, funded by FEMA, was most beneficial; 2) Given the regional impact of an earthquake in the central U.S., and the problems inherent in urban heavy rescue as dramatized by the earthquakes in Mexico City and Armenia, it is apparent that the central U.S is not prepared to effectively respond to a major event; and 3) While it is accepted that the greatest potential for hazard reduction is a mitigation program that addresses existing, high hazard structures and facilities, progress on this front remains elusive. In essence, my assessment of the progress, problems and opportunities for earthquake hazard reduction supports the thrust behind S. 629: we need to strengthen the NEHRP by placing more emphasis on application, particularly in the central and eastern U.S. There are compelling reasons to focus more attention and national resources on the earthquake hazard east of the Rockies. We have much less of a technical and scientific understanding of the nature and dynamics of the hazard itself; the central and eastern U.S. is arguably more vulnerable to an earthquake for reasons cited above; and the regional impact of an earthquake, notably in the central U.S., presents a unique set of problems in coordinating awareness, mitigation and response planning efforts.

Effectiveness of the NEHRP and recommendations on how to strengthen the program.

The effectiveness of the NEHRP in the next five years will, to a large extent, be a function of the progress that is made in the following areas: 1) Development of a broad based and unified "earthquake constituency", particularly in the eastern U.S.; 2) Ability to focus research, and apply the research towards problems that are identified by users; 3) The emergence of a more aggressive federal role in response

planning for an earthquake; 4) Development and implementation of a marketing strategy for earthquake hazard reduction, one that produces results; and 5) Increased support (funding and technical assistance) for regional, state and local earthquake preparedness organizations, particularly in the central and eastern U.S.

The premise behind my assessment is that the NEHRP needs to be approached more from a "bottom up" strategy, one that incorporates the problems and needs of the practitioners of earthquake preparedness and hazard mitigation. The following is a brief discussion of each of the five "determinants" of effectiveness, with emphasis on strengthening the NEHRP.

1) **Developing, Motivating and Effectively Utilizing an "Earthquake Constituency"**

The NEHRP needs to be a catalyst for promoting leadership and a greater involvement of key groups in the earthquake hazard reduction effort, including national media, national professional associations, leaders in business and industry, and elected officials at all levels of government. There needs to be a greater integration of NEHRP objectives into the agendas of key national associations, trade and professional. Earthquake hazard reduction also needs to be incorporated into medical, engineering, planning and public administration curriculums across the country. The NEHRP agencies should be more aggressive in developing a national earthquake constituency, and targeting education and awareness programs towards the leadership of key national groups. The bottom line is that it is easier and more productive to sell earthquake hazard reduction through the leadership of key, essential groups.

Constituency building can also be an effective mechanism at the regional or state level in increasing funding support. One of CUSEC's goals in the next 18 months is to expand the organizations's resource base through a constituency building initiative. In view of the limitations on federal funding to support earthquake preparedness organizations, constituency building and resource development can prove to be mutually supportive.

2) Improving the Management of NEHRP Research

There are several aspects of the research issue. First, there needs to be more coordination and dialogue between the NEHRP agencies and the users or practitioners to insure that the research that is being conducted is relevant to the problems in the field. We can all point to studies that sit on shelves, often times due to the absence of input from users on research priorities. This is particularly important in the field of societal response research, which is coordinated by the NSF. Secondly, there needs to be more authority delegated to the lead agency under the NEHRP to manage the research function. To date, each agency coordinates the research that is conducted within its limited area of responsibility. The frustration at the practitioner level is that much of the research - including social, scientific and engineering - is too technical, redundant, or irrelevant to the needs of the users. Finally, there needs to be more attention given to the dissemination of research, particularly through application workshops or through regional organizations, such as CUSEC, which can serve as clearinghouses. To summarize, steps should be taken to centralize the coordination and management of research under the NEHRP to maximize the application of research dollars, and to ensure that the needs of the users are reflected in the decision making process.

3) Integration of Earthquake Response with other FEMA Programs

One of the major accomplishments under the NEHRP is the preparation of loss estimate studies for the major seismic risk areas of the nation. However, FEMA should assume a more active role in conducting workshops that link these loss studies to lessons learned in heavy rescue and other areas of response. Furthermore, there has been little inclination on the part of FEMA to promote a national system of emergency medical services that would address multi-jurisdictional problems (such as communications). In short, there is a void at the federal level in applying the lessons learned from major earthquakes, and FEMA should clearly be the catalyst in such an effort.

The following recommendations are offered to strengthen the emergency response component of a national earthquake program: 1) FEMA should assume an aggressive role in integrating the earthquake program with the rest of the agency's programs for developing an all-hazard emergency response capability; 2) The

medical profession needs to be included, as part of a constituency building initiative, in an effort to expand the role of the medical profession in disaster response; 3) FEMA should take the lead in urban heavy rescue training; and 4) FEMA should be more active in sponsoring "lessons learned" workshops and seminars following a major earthquake. These activities can be useful in promoting awareness, mitigation and constituency building initiatives.

4) Marketing Strategy for Hazard Reduction

While the first decade of the NEHRP can be judged a success in terms of developing a body of knowledge on how and why earthquakes occur, and what their impact will be on people and property, the effectiveness of the NEHRP in the next five years and beyond will be determined by how well we (researchers and practitioners) can sell the hazard reduction program to key decision makers and the public. Put another way, it is time to translate research into meaningful action. It is no longer adequate to simply raise the awareness of the earthquake risk, it is more important to modify attitudes and behavior.

In developing and promoting a marketing strategy, the NEHRP should focus on integrating the "constituency building" element with research findings (and lessons learned) from previous experience with promoting hazard reduction. In essence, it is important to identify key groups that can serve as "vehicles" for marketing the strategy, such as the national media, law makers, chief executive officers of major corporations that have a vested interest in earthquake preparedness, leaders of community groups, and others. Secondly, a marketing strategy needs to incorporate the findings, the "do's and don'ts" of NEHRP sponsored societal response research. The Expert Review Committee (appointed by FEMA to review the NEHRP) concluded that such research is critical to a hazard reduction program, but also noted that research in the social-psychological-behavioral aspect of the program was deficient. Finally, the NEHRP should borrow from the experience and expertise of private sector advertising and public relations agencies in developing a strategy to effectively market hazard reduction measures.

5) Place More Emphasis on Support to State and Regional Earthquake Consortia

The impetus behind S. 629 is to invigorate the NEHRP through a more centralized management approach that places more emphasis on the application of a decade of research and experience. In many respects, the effectiveness of the NEHRP is commensurate with the health and well being of the regional, state and in some instances local organizations that ultimately are responsible for implementing many of the NEHRP provisions. In this context, I suggest that a balanced, national program to reduce the earthquake hazard include increased funding support for state and local participation. This is particularly important in high risk areas of the central and eastern U.S., where some states are going to have difficulty meeting the 50 percent cost share for federal funds beginning in FY 90. The point is, the funding base for implementation of the NEHRP is eroding, and this needs to be addressed.

Recommendations for S.629, A Bill to Amend the National Earthquake Hazards Reduction Act of 1977

I agree with and support the rationale behind the bill to amend the National Earthquake Hazards Reduction Act. As a practitioner with responsibility for implementing many of the provisions of the NEHRP, I have been frustrated by the fragmentation at the federal level, which calls to mind the problems and frustrations in the emergency management field prior to the creation of FEMA. We now need a "911" for earthquake hazards reduction.

There are three fundamental, interrelated factors that need to be present if we are to effectively strengthen and invigorate the national program: 1) There needs to be centralized management authority, including legislative authority, to set program priorities and to allocate agency resources to address those priorities; 2) The lead agency should have a well established, professional and organizational networking capability at the regional, state and local level; and 3) The federal agency responsibilities and functions assigned to each of the four NEHRP agencies should be given higher priority and visibility within that agency.

To fulfill the intent of S. 629, all three conditions need to be met. I am not convinced that they are.

24-223 O - 90 - 3

1) Centralized Management Authority

From a resource standpoint, the USGS may be the appropriate agency to have the central management authority and responsibility. The USGS is oriented towards basic research, and to a lesser extent research application. The agency currently administers the lion's share of the NEHRP budget. This budget supports a staff of over 400 people. Assuming that the focus of the NEHRP in the next decade will be on pre-disaster earthquake hazard mitigation, this staff would have to be redirected. Then a case might be made that the USGS is in the best position to manage the NEHRP. However, as I stated previously, to assume centralized management of the NEHRP, the lead agency must be given legislative authorities vis-a-vis the other agencies.

It must be acknowledged, however, that FEMA has been active in the mitigation field, and has effectively leveraged limited funding to implement a variety of programs that address mitigation.

2) State and Local Network

To reiterate a point made earlier, the effectiveness of the NEHRP in the next five years will largely be a function of how effectively the NEHRP agencies can channel resources (funding and technical assistance) and relevant research to the organizations at the state and local level that have the responsibility for implementing the program. There needs to be a two way dialogue between NEHRP agencies and practitioners. There must be an organizational network in place if the NEHRP is truly going to become more field oriented and reflect the problems, issues and opportunities at the state and local level.

The USGS does not have such a network of professionals in place, in the field, who are equipped and trained to provide the type of support that is needed to make a "quantum leap" in the program. The leadership of state programs is drawn from the emergency management field, not from the scientific community. In essence, the lack of an administrative infrastructure at the state and local level is the single greatest obstacle to overcome if the USGS is to be effective in the lead agency role.

3) Greater Visibility of Earthquake Program in NEHRP Agencies

Finally, it is important that NEHRP responsibilities be given higher priority and visibility in all four agencies, particularly the lead agency. The authors of S. 629 recognize the importance of this by requiring that the interagency committee be composed of the Directors of the four agencies. However, there needs to be more agency resources devoted to the program if the initiatives envisioned by the Expert Review Committee and others are to be accomplished.

Who should be the lead agency in the NEHRP? While the USGS may be suited from a programatic viewpoint, FEMA has an established management network and experience in working with state and local preparedness officials. However, I would support FEMA's continued leadership role only if there was a firm commitment to applying the necessary resources to get the job done, and that the program be fully integrated with other aspects of FEMA's mandate.

In the final analysis, I think the lead agency question tends to obscure the most important issue, and that is the need to channel more resources - funding, technical assistance and relevant research - to the organizations that have ultimate responsibility for implementing the NEHRP.

Senator ROBB. Thank you very much, Mr. Suiter.

We also have another dimension of this problem, and that is the economic considerations that ultimately occur when any kind of disaster strikes. And insurance is one of the ways that we share that risk or distribute that risk.

Mr. George Bernstein has not only had extensive experience in this area, but he recently chaired a panel of experts which reviewed the whole NEHRP program. And we would like now, if we may, to hear from Mr. Bernstein.

STATEMENT OF GEORGE BERNSTEIN, CHAIRMAN OF THE EXPERT REVIEW COMMITTEE OF THE NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM

Mr. BERNSTEIN. Thank you, Mr. Chairman.

I would like to state at the outset that I am here today in my capacity as having been Chairman of the Expert Review Panel and that nothing I say speaks for the insurance industry on the insurance earthquake issue at all.

Senator ROBB. That is understood.

Mr. BERNSTEIN. I think I was probably chosen to head the panel based on, not my insurance expertise, but on my background as having run the Federal flood insurance program and riot reinsurance programs and the crime insurance programs as the first Federal insurance administrator, and having had experience with the various Federal agencies that perform functions for the Federal Insurance Administration.

I would like to say also at the outset that I think Senator Danforth has cut short very greatly my remarks, because what he said is the thrust of the message that I want to bring here today.

I think that I admire the concern of the authors of the legislation. I am impressed by the growing awareness in the Congress of the earthquake hazard. But I think we have not gone nearly far enough.

I am concerned, in fact, that the legislation introduced misses a tremendous opportunity to deal significantly with the earthquake hazard that is just beginning to be understood as more than a California problem.

With the exception of the shift from FEMA to USGS, I really have no argument with the legislation. It represents an improvement on the 1977 Act, but it sure as hell does not represent twelve years worth of improvement.

Unless and until the United States is prepared to commit adequate resources to earthquake hazards reduction and to structure the program in a practical manner, we will just be tinkering with the problem, without having any measurable impact.

It has been twelve years since Congress enacted the National Earthquake Hazards Reduction Program. Progress has, not surprisingly, been slow but measurable. It has not yet reached the level where there is either nationwide appreciation of the risks of the earthquake or the commitment of resources that are necessary to achieve the purpose of NEHRP.

Despite the likelihood that a single major United States earthquake could inflict damages of $60 billion and more—and we have seen scenarios today, both described by Dr. Ketter and in the film that we saw—we are talking about multi-billion dollar exposure and probably the greatest hazard to this country that is of potential today. And yet, the entire NEHRP funding is a pathetic $65.9 million.

In constant funding, that is less than two-thirds of the original 1977 appropriations. Even the $198 million budget proposed by the Expert Review Committee is modest and recognizes current fiscal constraints.

But without increases to this minimum level, we will give no more than lip service to the goals of the Earthquake Hazards Reduction Program. To enact legislation with the best of intentions, but without necessary funding, accomplishes little.

In fact, it is probably counterproductive, because it will lead people to believe that something substantial is being accomplished and in fact nothing is.

With respect to the shifting by S. 629 of the leadership responsibility to USGS from FEMA, the Expert Committee reviewed and considered and rejected the movement of such role from one NEHRP agency to another. The committee recognized why FEMA was originally made the lead agency and cited GAO's justification for its continuing that role:

"It has a closer relationship with state and local governments and is more concerned with operational application of the earthquake mitigation measures."

Nevertheless, the Earthquake Review Committee's unanimous conclusion was that, regardless of the fact that one agency might be better equipped than others to perform lead role functions, no single agency of the NEHRP agencies could really do the job.

There was an inherent conflict in designating a first among equals. The committee believed that it was institutionally impossible for FEMA, USGS, or any other NEHRP agency to perform the leadership role required under the Act.

The essential requirement that the lead agency actually lead and, as the Act calls for, "recommend goals, priorities, budgets and target dates for implementation of the program" to partner Federal agencies is unrealistic, given the way government operates in actuality.

And having run the Federal flood insurance program and dealt with the various other Federal agencies, I know from first-hand experience the impracticality of expecting an agency that is equal—and in fact, USGS is not even equal to FEMA, but forgetting that role in terms of levels, an equal agency cannot dictate.

It cannot say to OMB, it will not be permitted to say to OMB, the budget for A, B, C, or D should be Y. The Administration would not let it, and that does not matter what administration it is. It is not going to happen in practical terms, and it is a wish and a prayer to think that moving it to USGS from FEMA will accomplish that.

Interestingly, the Expert Review Committee was comprised of appointees of every one of the NEHRP agencies—Federal Emergency Management Agency, U.S. Geological Survey, National Science Foundation, and the National Bureau of Standards, which is now known as the National Institute of Standards and Technology.

Despite what might be expected to be a protective attitude by these appointees, they unanimously concluded that only the creation of an independent oversight commission, with the leadership responsibilities and the authority to implement its mandate spelled out in the Act, could achieve the Congressional intent. This extraordinary unified decision bespeaks the need for the recommended change.

The Expert Review Committee appreciated the political difficulties and turf battles inherent in the establishment of such an oversight commission, even though it would have no research or operational roles, such roles continuing to be implemented by the agencies having NEHRP responsibilities.

The Expert Review Committee also anticipated a reluctance on the part of Congress to establish any new entity because of a reluctance to create a new bureaucracy and a concern with the potential of increased costs, although the proposed role of the oversight preparedness would be limited, as is that of its paradigm, the California Seismic Safety Commission, which has successfully performed similar functions for over a decade and has a current budget of $1.1 million.

I would like to take only one issue with something Dr. Ketter said, and it is really on emphasis. We knew what the political problems were, but we were not engaging in an academic discussion to present some pie in the sky proposal. We felt we had a responsibility to deal with the

problems and the workings and non-workings of the existing legislation, and we did that.

And we recognized the role that we would be asking Congress to play in taking hold of that problem. But that is what Congress is for, and if Congress is unwilling to take hold of that issue and not see that, no matter where the lead agency role is, if it is in an equal agency nothing that Congress wanted in terms of leadership is going to be fully accomplished, then that is a failing of Congress and not of the committee.

So I do not think that we were unrealistic. I think we recognized the problems. We are saying to the Congress: If you want to solve this problem, you have got to deal with that problem and deal with the turf and the political battles involved.

Unless we face up to the real reasons that NEHRP has not been more effective—underfunding primarily and the impossibility of the leadership role being carried out—we will squander a real opportunity for taking action at a time when people, including those east of the Rockies, are finally beginning to pay attention to the earthquake hazard.

We will also ensure continued unpreparedness for the major earthquakes that are coming, and we can expect our successors to be here ten years hence still debating how we can make NEHRP work.

To prepare for a major earthquake requires major action. Without denigrating the intent of S. 629, I do not believe that it will result in such action.

Thank you very much.

[The statement follows:]

Testimony of

GEORGE K. BERNSTEIN

Chairman of the Expert Review Committee
The National Earthquake Hazards Reduction Program

The Subcommittee has requested that as Chairman of the Expert Review Committee of the National Earthquake Hazards Reduction Program, I comment on S. 629 and summarize the Commentary and Recommendations of the Expert Review Committee.

I would like to express my admiration for the concern with the very real but still unappreciated threat of earthquakes in the United States that is represented by these hearings and the introduction of S. 629.

Nevertheless, I am concerned that the proposed legislation misses an opportunity to deal in a significant way with the earthquake hazard that is just beginning to be understood as a major, imminent and nationwide threat to life and property throughout the United States.

With the exception of the shift from the Federal Emergency Management Agency ("FEMA") to the United States Geological Survey ("USGS"), I have no argument with the legislation. It represents an improvement on the original 1977 Act.

Unfortunately, it is does not represent 12 years worth of improvement. Unless and until the United States is prepared to commit adequate resources to earthquake hazards reduction and to structure the program in a practical manner, we will just be tinkering with the problem without having a measurable impact.

It has been 12 years since Congress enacted The National Earthquake Hazards Reduction Program ("NEHRP"). Progress has, not surprisingly, been slow but measurable. It has not yet reached the level where there is either nationwide appreciation

of the risks of earthquakes or the commitment of resources that are necessary to achieve the purposes of the NEHRP.

Despite the likelihood that a single major United States earthquake could inflict damages of $60 billion, the entire NEHRP is currently funded at a pathetic $65.9 million. In constant dollars, that is less than two-thirds of the original 1977 appropriation.

Even the $198 million budget proposed by the Expert Review Committee is modest and recognizes current fiscal constraints, but without increases to this minimal level, we will give no more than lip service to the goals of earthquake hazards reduction.

To enact legislation with the best of intentions, but without necessary funding accomplishes little. In fact, it may be counterproductive if it leads people to believe that something substantial is being accomplished.

With respect to the shifting by S. 629 of leadership responsibility from FEMA to USGS, the Expert Review Committee considered and rejected the movement of such role from one NEHRP agency to another. The Committee recognized why FEMA was originally made the lead agency and cited GAO's justification for its continuing in that role: "it has a closer relationship with State and local governments, and is more concerned with operational application of earthquake mitigation measures."

Nevertheless, the Expert Review Committee's unanimous conclusion was that regardless of the fact that one agency might be better equipped than others to perform lead agency

functions, no one of the NEHRP agencies could really do the job -- there was an inherent conflict in designating a "first among equals". The Committee believed that it was institutionally impossible for FEMA, USGS or any other NEHRP agency to perform the leadership role required under the Act.

The essential requirement that a lead agency actually lead and "recommend . . . goals, priorities, budgets and target dates for implementation of the program" to partner federal agencies is unrealistic, given the way government actually operates.

The Expert Review Committee was comprised of appointees of every one of the NEHRP agencies: the Federal Emergency Management Agency, the U. S. Geological Survey, the National Science Foundation and the National Bureau of Standards (now known as the National Institute of Standards and Technology). Despite what might be expected to be a protective attitude on the part of the members, they unanimously concluded that only the creation of an independent oversight commission, with the leadership responsibilities and the authority to implement its mandates spelled out in the Act, could achieve the Congressional intent. This extraordinary unified decision bespeaks the need for the recommended change.

The Expert Review Committee appreciated the political difficulties and turf battles inherent in the establishment of such an oversight commission even though it would have no research or operational roles -- such roles continuing to be implemented by the agencies having NEHRP responsibilities.

The Expert Review Committee also anticipated a reluctance on the part of Congress to establish any new entity because of a reluctance to create a new bureaucracy and a concern with the potential of increased costs -- although the proposed role of the oversight commission would be limited, as is that of its paradigm, the California Seismic Safety Commission, which has successfully performed similar functions for a decade with a current budget of only $1.1 million.

Unless we face up to the real reasons that NEHRP has not been more effective -- underfunding and the impossibility of the leadership role being carried out -- we will squander a rare opportunity for taking action at the very time when people, including those east of the Rockies, are finally beginning to pay attention to the earthquake hazard. We will also insure continued unpreparedness for the major earthquakes that are coming, and we can expect our successors to be here ten years hence, still debating how we can make the NEHRP work.

To prepare for a major earthquake requires major action. Without denigrating the intent of S. 629, I do not believe that it will result in such action.

The Expert Review Committee summarized its commentary and recommendations as follows:

RESEARCH

Since passage of the Earthquake Act in 1977, knowledge has increased significantly about earthquake processes, frequency

of earthquake occurrence, ground motions, faulting mechanisms, ground failures, and the effects of these phenomena on man-made facilities (designated "the built environment" by the Committee). Research has led to advances in designing and constructing facilities, an increased ability to predict earthquake events, and overall improvements in earthquake hazards reduction techniques. Despite this progress, considerable research still is required if the Nation is to achieve an acceptable level of earthquake hazards reduction.

To help in reaching that level, the Committee recommends that NEHRP research efforts over the next five years be concentrated on:

- Completing, upgrading, and maintaining national and regional networks for collection of seismologic data;
- Establishing a national program (in cooperation with private sector interests) for acquisition and distribution of strong-ground-motion data, and developing new instrumentation to measure ground-motion response;
- Establishing a program for upgrading experimental facilities for earthquake engineering in the U.S. while continuing feasibility studies on a large-scale testing facility;
- Promoting state-of-the-art earthquake engineering by establishing additional engineering research centers and expanding regular programs of principal investigator grants;
- Continuing seismic geology investigations of fault behavior, including fault geometry, rupture mechanisms, and earthquake recurrence, particularly through an expanded program of individual investigator grants;
- Developing comprehensive earthquake prediction technology based on systematic processing of relevant data, balanced in terms of long-, intermediate-, and short-term predictions, and including a mechanism for efficiently transmitting information about earthquake predictions to officials responsible for emergency preparedness;

- Implementing multidisciplinary prediction experiments similar to that in Parkfield, California, in four to six key seismic areas;
- Enhancing support for research on a broad range of societal issues;
- Improving the procedures for postearthquake studies and enhancing the accessibility to do such studies.

Within the parameters of NEHRP research, the Committee encourages the NEHRP agencies to more aggressively pursue cooperative and mutually beneficial research with the private sector. The Committee also urges continued support for the cooperative, international earthquake research efforts currently underway. Finally, the Committee is concerned about the relevance to the NEHRP of some of the research currently being funded under the NSF Earth Science Division, and seeks a commitment by that Division to undertake research that is more directly focused on earthquake processes.

IMPLEMENTATION

In enacting the NEHRP, Congress recognized that reducing loss of life and property from damaging earthquakes would require effective earthquake hazard reduction measures. Significant activities, such as publication of the NEHRP Recommended Provisions for Development of Seismic Regulations for New Buildings, the Action Plan for Reducing Earthquake Hazards of Existing Buildings and the supporting handbooks and manuals, are stimulating mitigation activities. State and local hazard-reduction programs are underway in 17 high-hazard, high-population areas. Effective education projects have been

developed for schools and targeted professions, and earthquake information centers have been established. Although significant progress has been achieved, greater emphasis must be placed on implementation if the goals of the Act are to be realized within the next decade. To this end, the Committee recommends that over the next five years NEHRP implementation activities focus on:

- Accelerating the development of, and updating, the tools necessary for effective state and local hazard reduction programs (postulated earthquake scenarios, and appropriately detailed damage and loss estimates for all risk areas are two examples);
- Establishing additional regional planning consortia, such as the Southern California Earthquake Preparedness Project (SCEPP) and the Bay Area Regional Earthquake Preparedness Project (BAREPP), in high-risk areas, and enhancing local government participation;
- Establishing a mechanism to accelerate the development of transferable earthquake engineering advances, their adoption into model codes, and subsequent enforcement;
- Developing the technical and societal tools necessary to implement and promote a comprehensive, national retrofit program for existing hazardous structures;
- Enhancing targeted education programs for the broad spectrum of professionals, both public and private, responsible for earthquake hazards reduction programs, using the resources of professional associations whenever appropriate;
- Developing improved mechanisms for translating research results into application, establishing links between researchers and users, and enhancing dissemination of information through workshops and clearinghouses;
- Designing a coordinated strategy to "market" earthquake hazards reduction to all elements of U.S. society.

The Committee focused considerable attention on the need to continue to attract talented, trained individuals to the disciplines involved in earthquake hazards reduction. To assure

the continuing availability of well-trained professionals, the Committee recommends that NEHRP agencies establish a coordinated program to augment existing research grants with a new program of competitive fellowships in earthquake hazards reduction.

The Committee also confirmed the need for and benefits of the proposed International Decade for Natural Hazards Reduction, and recommends that NEHRP agencies work closely with the National Academy of Sciences to effect the goals of that project to reduce the impacts of natural hazards through coordinated research, data-gathering, and information-sharing.

EARTHQUAKE INSURANCE

During initial Committee discussions, it became apparent that earthquake insurance is a major issue that could impact the NEHRP significantly over the next five years. The Whittier Narrows earthquake on October 1, 1987, was a reminder of the ever-present hazard and the need to examine carefully the role of earthquake insurance in the NEHRP. The Committee is aware of the potential impact of a catastrophic earthquake, not only on life and property, but also on the economic stability of the Nation.

The 1977 Act specifically calls for the NEHRP to determine the appropriate role of insurance in moderating the impact of earthquakes. Although the concept of earthquake insurance has been the subject of several reports, some of which have been prepared under the NEHRP, fundamental questions remain unanswered. As this report is being written, the insurance industry is developing proposed earthquake legislation that provides for a

Federal government role in both insuring and reinsuring this hazard. The Committee recommends that a comprehensive review and analysis be initiated immediately to determine whether there is a role for the Federal government in earthquake insurance, the extent to which mitigation is essential for Federal earthquake insurance or reinsurance, and to answer the questions raised in the December 1986 Congressional Research Report on earthquake insurance.

THE LEADERSHIP ROLE

One of the most important issues addressed by the Committee was that of leadership of the NEHRP. Serious questions were raised regarding FEMA's performance in its assigned role and, indeed, whether any NEHRP agency could effectively carry out that role. Discussions centered around interpretations of the lead role as that of program advocate, program manager, or program coordinator. The Committee agreed that all these functions were essential to true leadership, and recognized the difficulties faced by any single agency in carrying out the lead agency role.

Confronting not only FEMA, but also the other principal agencies, are NEHRP conflicts with overall agency priorities, budgetary and programmatic constraints, and agency operations. Consequently, to ensure that the lead role is executed as mandated in the 1980 amendments to the 1977 Act, the Committee recommends the creation, by statute, of a "Federal Earthquake Oversight Commission," the sole responsibility of which would

be to exercise the NEHRP leadership role currently assigned to FEMA. The commission would have no research or operational roles, but it would have the authority to recommend to The President the roles, responsibilities, goals, priorities, target dates, and budgets for Federal agencies involved in the NEHRP.

FUNDING

The review of the NEHRP by the Expert Review Committee and the recommendations to be addressed by the principal agencies in 1989-1993 demonstrate forcefully that every part of the NEHRP is now funded at a level well below that required to achieve the primary goal of reducing losses of life and property on a time scale acceptable to society. Clearly, scientific advances have occurred, accomplishments in all areas of the NEHRP can be noted, and limited new initiatives have been undertaken. Progress, however, has not been commensurate with the potential risks we face. The first-year budget, designated in the 1977 Act that established the NEHRP, was approximately $53 million. In 1980, funding was added to cover the addition of FEMA and NBS to the Program. Inflation over the past ten years has eroded the NEHRP budget despite the Program's important statutory mandate. In constant dollars, $53 million in 1977 equates to $106 million in 1987. Total funding for the NEHRP in 1987 is a mere $66 million. In real purchasing power, this means that the 1987 funding is less than two-thirds of the funding appropriated in 1977.

This Nation tends to react to, rather than anticipate, crises and disasters, and funding of the NEHRP reflects this

approach. Earthquakes have caused, and will cause, enormous loss of life, injury, destruction of property, and economic and social disruption. Damage estimates for the Whittier Narrows earthquake, moderate by accepted standards, are in excess of $358 million just for direct earthquake losses. Other damages, such as loss of lives, personal injury, unemployment, and business interruption, will be incurred in addition to this amount. A postulated Richter magnitude 8.1 earthquake in southern or northern California could potentially kill and injure tends of thousands of people and cause more than $60 billion in damages; but earthquakes are not just a California hazard. A postulated Richter magnitude 7.5 earthquake on the Sale Lake City segment of the Wasatch fault could potentially kill and injure thousands of people and cause more than $8 billion in damages.

Such losses, destruction, and disruption can be reduced substantially through the development and implementation of appropriate programs. The number of such programs will not be adequate if the NEHRP is continued only at its current funding levels. NEHRP funding is so eroded and some parts of the program are so poorly funded that momentum gained by recent advances in knowledge is dissipating, and there is great danger that the experts working in the component parts of the NEHRP may soon be forced to direct their energies to other fields to survive. Many of the issues and recommendations included in this report are not new. Inadequate funding over the years has precluded their resolution.

This bleak picture can be reversed. In discussing funding for the NEHRP, the Committee was fully cognizant of the myriad problems and competing priorities facing the Nation. Historically, investment in mitigation, specifically in earthquake hazard-reduction measures, has proved to be fiscally responsible and demonstrably beneficial to society. The Whittier Narrows earthquake provides recent evidence for this statement. The preliminary estimate of $358 million in damages largely reflects the failure of poorly constructed structures. Buildings that were seismically strengthened generally performed well. Earthquake drills and other preparedness activities were effective in schools where adults and children reacted as they had been taught.

The Committee recommends an annual budget for the NEHRP of $198.4 million for each year included in the revised Five Year Plan 1989-1993. To put this amount in perspective, $198.4 million represents only three-tenths of one percent of the total damages of $60 billion estimated to result from a single major U.S. earthquake. As the report documents, adequate advances in earthquake hazards reduction will not be accomplished without the recommended increase in funding.

Attached as an appendix are the funding increases proposed by the Expert Review Committee.

Although S. 629 does not adequately address the earthquake problems facing the United States, the Expert Review Committee is grateful that the Congress is addressing the National Earthquake

Hazards Reduction Program. It is hoped that more substantive action will be taken, and the Expert Review Committee is prepared to make its expertise available to the Subcommittee.

Senator ROBB. Thank you very much, Mr. Bernstein.

All three of our panelists have given us quite a bit to think about in terms of what the responsibilities ought to be and so have various members of this committee.

We will have an opportunity for some brief questions. I am going to ask that we observe the five-minute rule at this point so that we can get on. We do have a second panel this morning and we have got some interesting questions to ask of them as well, so we do not want to go too far over,.

Let me begin just very briefly with you, Dr. Ketter and try to get the attention of those outside the seven-state area you spoke of. The presentation that we saw mentioned the collapse of two skyscrapers in the Memphis area and the resultant loss of life and what have you.

What about cities like New York or Washington? Can you give us any indication of the potential risk or the chances that major East Coast cities could experience this same type of devastation?

Dr. KETTER. We have looked at New York City with regard to a repeat of the earthquake that occurred in the late 1880's in Jamaica Bay, and we went through a scenario similar to that one. And while there would be no major building failures, you might be interested to know there would be between $6 and $7 billion worth of damage in the New York City area, because they have allowed building on particular types of soil and particular types of construction practices that would in fact make them quite vulnerable.

If that earthquake had been moved to 125th Street, which is a major fault in the New York City area, which is only about five miles down, we postulate that the extent of damage would be considerably greater. So I can tell you about the New York City area.

We have looked at the Boston area, everything from New York City to Boston to the Great Banks, and that is a potentially very probable area for an earthquake. So is the Eastern Appalachian from Tennessee on north and not too distant from Washington; you could have a major earthquake there as well.

The difficulty between the East and the West is twofold: One, the West has had an adequate time to handle the earthquake problem in a year-sequential form. When they built, they in fact made corrections. They have an earthquake code in place, they continually update it.

Only Massachusetts and California actually have on their books any earthquake codes. Although, we believe Connecticut has enacted one that will go into effect July the 1st, as a result primarily of the work that we have been doing.

The building construction practices in the central and the easterr. part of the country are not good in terms of design codes, in terms of land use planning, things of this nature. You will find major devastation from earthquakes that are much less than that that we are talking

about. We are talking in the St. Louis area or St. Louis south to Memphis, you are talking about things in the order of 7, 8 on the Richter scale.

We can talk about 6, which was a repeat of the Chicoutimi earthquake, and if you move that down into the Adirondacks in New York State you are going to find that Boston has problems, you are going to find New York City has problems, you are going to find all the way down to Washington will have problems, and not just from buildings.

You have got an awful lot of dams that are earth-filled dams, many of which have not been inspected. These were built from the late 1800's up until ten years ago, and they are, a number of them, grossly inadequate to handle that problem.

And you are going to have major floods. You are not talking about floods yet. You are going to have major fires. New York City, for example, has mostly cast iron pipes for the gas lines. Those do not take shaking of this type.

I hope I am answering your question.

Senator ROBB. It is a matter of including more people in the worry contingent, I guess, so that we have greater attention to the problem.

Dr. KETTER. And that is what I think that the Center at Buffalo has been trying to do. We have since last February held a number of conferences, and I think that we are getting an increased awareness. But we are not the only one. FEMA is doing that, USGS is doing that, the various professional organizations are.

Senator ROBB. Is there any place in the country today that those who reside there could be virtually certain that they were free of any risk of a major earthquake?

Dr. KETTER. The only place where I found where we have no record of anyone having felt anything I think is North Dakota. If you would like to move to the North Dakota area, maybe you would at least have a greater chance.

Senator ROBB. For those land speculators that want to get ahead of the curve, there is your tip, folks.

One other question, and this is obviously a lay question from someone who does not pretend to be a seismologist. Is there any research and development into techniques that might do in the earthquake prevention area what we do with avalanches, detonating explosives in snow and ice to protect skiers or others in mountainous areas?

Is there any way to trigger a smaller earthquake that might cause less damage and reduce the likelihood of the large quake?

Dr. KETTER. There have been studies done in other parts of the world where you were reasonably certain that an earthquake would occur within a given period of time along a particular fault line. The amount of energy that would be required to substantially change the course of history is rather large.

Outside of the areas where you have a known surface fault, such as the San Andreas fault or the Hayward fault or others, you are playing Russian roulette. We do not know in the central and eastern part of the United States, for example, where the next earthquake will occur.

They do occur most often where you have had them before, but the Chicoutimi earthquake occurred where none had been. This is the one up in Canada. And we would expect the same thing will occur here.

Therefore, I think putting your hopes on releasing energy such that you would foreclose one, I think that the research has not gone that far that I would want to risk it. I think you are causing great problems without any great assurance of any success.

Senator ROBB. Thank you, Dr. Ketter.

I am going to ask now if Senator Danforth has some questions. I understood that you had to depart or something?

Senator DANFORTH. I am going to depart at 11:30.

Senator BRYAN. I would be happy, Mr. Chairman, to yield to Senator Danforth first.

Senator DANFORTH. Thank you.

Let me ask you a parochial question. The New Madrid fault, named for New Madrid, Missouri——

Dr. KETTER. Which is now in the middle of the Mississippi.

Senator DANFORTH. Yes, that is right. And a big lake was created over in Tennessee.

But you say, as I remember, that the likelihood by the year 2000 of a 6.3 Richter scale earthquake at the New Madrid fault is 40 to 60 percent?

Dr. KETTER. I can give you the exact numbers. These are studies that were carried out by Johnson and Nava, and I think it is a little larger than that. But let me find the exact numbers.

6.3 would be 40 to 60 percent by the year 2000, and that 6.3 by the year 2035 would be 86 to 97 percent.

Senator DANFORTH. Now let us take the 6.3.

Dr. KETTER. Right.

Senator DANFORTH. What damage would that cause to St. Louis, do you know?

Dr. KETTER. I cannot tell you. I would in fact have to go back to the document that did in fact look at that and did calculate that. A 6.3 would be somewhere in the order of 1,000 times less severe than an 8.3 in terms of magnitude—no, 100 times less than 8.3 in terms of magnitude of shaking.

I would expect that there would be extensive building damage. You would find chimneys topple, you would in fact find cracks in foundations. You would find the possibility of broken pipes if they were not adequately set. You would find streets that might have difficulty of waviness.

Senator DANFORTH. Bridges?

Dr. KETTER. Bridges might have problems, older bridges definitely. The problem is the supports on bridges—in California they have been doing a lot to tie these together. New York State had a bridge that

went down because the supports were of a type that would not accommodate this kind of shaking.

Shaking was not the problem, it was flooding. But the same thing would happen. The bridges could come off the abutments.

Senator DANFORTH. Loss of life?

Dr. KETTER. I would suspect for 6.3 you might get a relatively small amount. That would not be the major problem, though. You would have a fairly substantial——

Senator DANFORTH. But closer to New Madrid, say Cape Girardeau, Missouri?

Dr. KETTER. Yes, Cape Girardeau would feel it. I understand why you are focusing on Missouri, that being your State.

Senator DANFORTH. It grabs my attention.

Dr. KETTER. I can understand why.

Cape Girardeau would feel it, New Madrid would feel it, and you could in fact have some damages. If it happened during the day and if you had a large number of children in school, I would be a little bit concerned that you might have some deaths of small children, even for that small an earthquake.

Senator DANFORTH. Now let me ask, Mr. Suiter, right now are we ready for a major earthquake?

Mr. SUITER. Not completely, sir, but we are a lot, lot more ready than we were five years ago in terms of certainly local jurisdictions, in terms of state government, in terms of regional plans, in terms of working with other states, in terms of sharing media markets—Memphis, Tennessee, as an example, is Mississippi, Tennessee, and Arkansas—in terms of the coordination of those things that are happening.

Arkansas this week just completed a major statewide exercise, in which the other states provided some information back to them. I have been up here with Big Bird, so I do not know the outcome of that exercise as we speak.

Senator DANFORTH. If there was an earthquake on the New Madrid fault tonight, would the Central States Consortium be ready for it? Would the states be ready for it? Would the State of Missouri be ready for it?

Mr. SUITER. The State of Missouri has made an enormous amount of progress over the last few years. Remembering that the Central United States Earthquake Consortium's job is not an operational one, it is an organizational one, one of coordination of resources and activities

Senator DANFORTH. But I am talking about what happens when an earthquake hits. Let us say that tonight it were to hit. Would we know what to do the minute it hits? Would we know who calls whom and what equipment is brought in and how we take care of the injured and how we provide hospital care, and all the things that go into dealing with that emergency?

Would we know what to do? Are we ready to deal with it?

Mr. SUITER. A simple answer to that is yes, from the standpoint that we can handle a lot of these things out there. It just simply overwhelms our resources. And the integration between us and the Federal level of

government, the military resources that the Senator was talking about a moment ago, has not been accomplished yet.

We are in the process of working through those things now. The national earthquake plan is being prepared.

If I could just make one more comment to your question of Dr. Ketter a moment ago about the St. Louis area in particular, about two years ago, or maybe it was 18 months ago now, through CUSEC all the member states gave up a certain amount of funding to provide that back so that the St. Louis study, like I have in Memphis, as an example, tells me what is going to be happening—we gave up portions of our money to go back to do the St. Louis, Missouri, study, because we feel that is a very important part of the entire area.

We need to know what is going to happen to the hospitals up there. We obviously will have to shift patients and things like that up.

It is not perfect. I do not want to mislead you at all. But again, we are a lot better off than we were. Yes, we know who to call. What we do not have is survivable communications systems right now.

Yes, we know how to get certain people involved, but we do not have, in terms of the banking community, how to get the economic impact, how to get that computer system back on line again, so that we have got money to do what we have to do.

All that has not been done yet, sir.

Senator DANFORTH. What do you think we should do? Mr. Bernstein has made some specific suggestions. He has talked about funding, he has talked about a lead agency. But if you were designing—and let me ask each of you this if I can. If you were designing—I think Mr. Bernstein has already answered.

If you were designing legislation that we should pass, what should be in that legislation?

Mr. SUITER. The same things that we talked about a few moments ago, much of what Mr. Bernstein talked about, and that has to do with centralized management authority. Get somebody, whether it is his commission or whether it is FEMA or USGS, whoever it is, give them control over the four agencies that are involved and the other agencies out there.

And then set up benchmarks, just like you did on the Title III legislation. You said—you passed a law that on October 17th we were going to do one thing under the Superfund and two years later we had to have other things done.

Establish the local networks and enhance the greater visibility within the agencies, provide the funding.

Senator DANFORTH. Dr. Ketter?

Dr. KETTER. Can I make one statement? You ask what can you do. One of the things that we have found out recently in some of the studies resulting from Armenia and prior to Armenia, is that we do not know how to carry out search and rescue operations associated with earthquakes. It is not known. We do not have the equipment in this country to do it, nor anywhere in the world.

We need to somehow address that problem because, while our construction practices are better here in this country, even in the East, than they were in Armenia.

It is difficult under the current arrangement to get the health people involved in the NEHRP legislation. If I were to do anything, I would say for God's sakes bring the Institutes of Health in as, I would not say an equal partner, but a major partner in trying to solve that problem with the others that are currently there. We have been approached by OFDA, by the World Bank and others to coordinate these activities.

I would hope NEHRP would have that capacity. But I must admit, up until now they are not addressing it.

Senator DANFORTH. Mr. Chairman, thank you very much. I would only say, I believe we are going to legislate. I hope we do, and when we do I hope we do it the right way. And we are dependent on you and others like you to tell us what should be in the legislation.

I do not want to go through this process of passing a bill and then making wonderful speeches on the floor of the Senate about what a great job we have done to deal with the earthquake problem when we have not done the job.

So will you please give some thought as to what should be in the legislation and contact the staff of this committee or us, the Senators, and let us know what you think should be in it. We will certainly give it every consideration.

Mr. SUITER. You can certainly count on us being frank and direct back with you.

Senator ROBB. Thank you, Senator Danforth.

I am going to ask that you formalize precisely what Senator Danforth has requested informally, that you make a specific reaction to the S. 629. Please comment on the impact of S. 629 on your individual agencies or those in your areas of expertise, and if you could be as specific as possible in terms of what legislation ought to cover, in terms of addressing the broader problem that we have talked about.

Senator Bryan.

Senator BRYAN. Thank you very much, Mr. Chairman.

Senator Danforth asked the question that I was going to ask. I too, think it would be very helpful if you could provide this information that the chairman has requested. I would also like for you to define for us very clearly and very concisely and with a minimum of bureaucratic words what you think the appropriate role of the states is and what the appropriate role of the Federal Government is.

You have already mentioned several things: the funding, the central communications systems. If you will, from that broad brush, give the specifics that what Senator Danforth has requested and detail what ought to be included in the piece of legislation that we are trying to process through the committee, I think that would be very helpful.

Mr. SUITER. We would be delighted to provide it to your staff, sir.

Senator BRYAN. From my own perspective it is clear that if this happens on your watch, you and Governor McWherter are going to have your hands full. I take it from your response to Senator Danforth that your contingency plan is in place.

Mr. SUITER. Yes, sir.

Senator BRYAN. You know what you need to do. I think you need to just kind of fill in those spaces in the contingency plan where you need some additional help. For example, do you have a uniform building code in Tennessee?

Mr. SUITER. Yes, sir, and that is coming up for reauthorization in the Assembly now, and we are examining what type of seismic provisions should be in there. And it is a controversial issue we are trying to work through.

Senator BRYAN. I mean, there are some things that I think are frankly the purview of the state, which at least this Senator would be very reluctant to preempt. On the other hand, I think it does require coordination. There is a partnership response that is going to be required. This is not just a single state; it is a regional problem.

And I think from your perspective, you have had a quarter of a century experience with emergency management service. I for one would appreciate your evaluation.

Thank you, MR. Chairman.

Senator ROBB. Thank you, Senator Bryan.

Senator Lott.

Senator LOTT. Thank you all for your testimony. I find it very interesting.

I just have two or three questions. First, Dr. Ketter, in the material we have before us there is an indication in here that at least one study, the one from one state—maybe Mr. Suiter would want to respond on this—says that there is a virtual 100 percent assurance that by the year 2010 there will be an earthquake in this area of the magnitude of 6 or greater.

How can you be 100 percent sure?

Dr. KETTER. You cannot be. You can say near 100 percent. The curve goes down very slowly. So you can say, okay, if you want to exclude the possibility of a tenth of one percent or something like that, I would say near 100 percent. I would not say absolutely 100 percent.

Senator LOTT. And this is based on certain geological factors?

Dr. KETTER. No, you in fact make the supposition that what has happened in the past will in fact be probable in the future, and then you use probabilistic principles, statistics principles. You take all of the known earthquakes in the particular area that you are looking at and you determine what is their magnitude, as opposed to their frequency of occurrence.

If you say that what has happened in the past will happen in the future, you can come up with probabilities that these will happen. I hate to use the word "like a gaussian distribution' on something like that. You are looking at the past, you are cataloguing and you are plotting the frequency of occurrence of a certain magnitude, as opposed to the number of years that it will happen.

Senator LOTT. That is so theoretical. Is there not something more substantial, scientific, something you could see and say, this is happening, so the probability is there will be this resulting cataclysmic event?

Dr. KETTER. As I said from the outset, seismology is not at the state where you have a deterministic answer. Where there is an equation that will tell you exactly when an earthquake will occur. There is no such information now available. Even for the San Andreas fault, there is no such information.

You can write it in terms of probabilistic assessment. That is all you can do.

Senator LOTT. It sure makes me nervous when you say 100 percent within the next 20 years.

Dr. KETTER. I would not say 100 percent. I would say near 100 percent.

Senator LOTT. Okay.

Let me address some questions perhaps to you, Mr. Bernstein. The legislation we have—let us get right down to it—proposes that there should be, I believe, a lead agency and that that should be USGS. And while I have been critical of FEMA and continue to be, I think, one, there should be a lead agency, and I think it should be FEMA. I think we need to clarify what we expect from FEMA.

And I do not want them coming in like they did after Hurricane Elena. I got a response. What is the Federal role? In the immediate aftermath of a disaster it can be, the Federal role, total responsibility.

If your local government and your state government are flat on their backs, roads are shut down, your sewer systems are shut down, communication is shut down, we do not have time to quibble over who is in charge. That is where, one of the few places where, I think the Federal government has a total role and responsibility.

So I think there should be a lead agency. I think they should understand their role. They should not come in and start equivocating over who is going to pay. They should not start coming in and saying—look, I am for the private sector as much or more than anybody. But when you have got debris stacked up six and twelve feet over your head in the streets, do not give me a lot of gobbledygook about bringing in private companies from Nevada or somewhere. Get out there and start shoveling and moving the debris.

Now, as to who should pay, I have a quick answer: FEMA pays. They should not pass the responsibility to USGS or the Seabies or the Air Force or Agriculture or anybody else. They have the responsibility or should have the responsibility to move in in a disaster, whether it is earthquake, tornado, hurricane, or whatever, natural disaster, and make things happen.

And if later on Congress has to provide more money to FEMA or Congress has to provide some more money to Agriculture or more money to Transportation, you know, we can worry about that later.

But in the initial phases, no question, we need a lead agency. If it is going to be FEMA, they are in charge and they should pay.

And as far as the private sector, that is fine when you have got time. But when you have got a disaster on your hands, you do not have time to be messing around with that sort of thing.

How do you respond to all that?

Mr. BERNSTEIN. Senator Lott, it would be presumptuous of me to speak for FEMA, and I am sure Mr. Becton will address your concerns in the area of preparedness and the reaction after the event.

I distinguish the role that our committee played. We were reviewing the National Earthquake Hazards Reduction Program and how that program and the leadership role in it could be better handled. We did not feel that FEMA's preparedness actions in terms of reaction to events once they occurred were deficient at all.

What we were concerned about was whether or not the various elements of the program—the research, the mitigation, the implementation of the program—whether these things were properly led to the point where they would be effective and where the hazards would be reduced through more understanding about earthquakes, more understanding of exactly the sort of scientific issues that you are concerned with to advance that to the point where we are more certain than we are today about how earthquakes occur, where they will occur, the extent to which not only our research but our implementation is improved.

We are concerned with all of that. But we were primarily concerned when we got to the leadership issue, not asking FEMA to pass the buck, not asking it to give its role in carrying out the program to USGS or anyone else. We believed that it was impossible for an agency like FEMA or USGS to do what Congress asked it to do, namely to propose budgets, to propose targets, priorities.

I think we all know what happens when it goes to OMB. Each one of those agencies is going to have its own examiners. Each one of those agencies is going to be very, very protective about how much money is spent here versus there.

We felt that unless there was someone on top directing that agency and the other agencies as to how and where it planned for hazard reduction, that planning would not take place, as it has not taken place adequately up until now.

Senator LOTT. Forgive me because I am new in this particular area and on this committee. I still do not understand. Are you saying a person or an agency on top, directing this?

Mr. BERNSTEIN. We suggested something akin to the California Seismic Commission, which has no operational functions. We would say that this agency would be a separate layer. It would be a commission above all of the other agencies.

And it would say the budget should be Y, the priorities should be X, and that would be its only role. And it would dictate to those agencies what they should recommend to OMB. And then you would have a clear picture. If that direction was not complied with, you would have some responsibility.

Senator LOTT. So you are advocating the creation of a new commission or super-organization to overview this and make recommendations and so forth?

Mr. BERNSTEIN. Exactly, in the preparedness role in terms of hazards reduction, not in carrying out the functions. All those functions would remain where they are today. USGS would have its functions, FEMA would have its.

But we know what happens when we see what a small percentage of the necessary money is recommended by the Administration within these own agencies. It is not going to work.

When the original Act was passed in 1977, there was thought of putting that super-agency, creating a super-agency or utilizing an existing one, the Office of Science and Technology in the White House. That agency demurred and it was decided you would set the level down below and you would have equal agencies.

It has not worked. It will not work. And unless you have some sort of super-commission—and I know we all hate the idea of that and the creation of a bureaucracy, and that is why I cited the fact that the California Seismic Commission, which I believe was created in 1975, still has a budget of only $1.1 million and has done a tremendous job in doing just what we are recommending, directing the roles of the implementing agencies.

That is what we are looking for this oversight commission to do.

Senator LOTT. I will have to think about that. Thank you very much, sir.

Senator ROBB. We are obviously not going to resolve that at this time.

I do not want to cut anybody off if they have a pressing question that needs to be responded to right now. If not, we are running a little long. We do have two more guests who are going to appear in the second panel.

There are several questions that have not been asked that we would like to submit in writing and ask Dr. Ketter, Mr. Suiter, and Mr. Bernstein, if you would be kind enough to respond. Clearly, there is a great deal of interest in the subject matter which is being discussed this morning. Your input can be extremely valuable to this committee and to the Congress in trying to resolve what the appropriate Federal responsibility will be.

I will have a federalism discussion with my friend Mr. Lott after this particular panel discussion is concluded. I do not think it is the time for it right now.

We thank you, Dr. Ketter, you Mr. Suiter, you Mr. Bernstein, for your participation this morning. We will look forward to being in touch with you as we consider this matter. Thank you.

If the final panel would be kind enough to come up and take their places, we will begin right away.

Gentlemen, thank you for your patience. We will go ahead and get started right away, because we are running a bit behind our original projected time schedule.

Our second panel consists of Mr. Julius Becton, Director of the Federal Emergency Management Agency, and Dr. Dallas Peck, Director of the United States Geological Survey. Mr. Becton and Dr. Peck represent two of the four agencies in the national earthquake program.

The other two agencies, the National Science Foundation and the National Institute of Standards and Technology, have submitted testimony for the record which will be included and available for the committee to consider when we are moving in this particular direction.

So far this morning you have had a great deal of time to hear what things are of interest to the members of the Committee . Mr. Becton, we are delighted to have you with us. We will be pleased to hear from you.

STATEMENT OF HON. JULIUS W. BECTON, JR., DIRECTOR, FEDERAL EMERGENCY MANAGEMENT AGENCY; ACCOMPANIED BY DENNIS KWIATKOWSKI, ASSISTANT ASSOCIATE DIRECTOR FOR NATURAL AND TECHNOLOGICAL HAZARDS; AND GARY JOHNSON, CHIEF, EARTHQUAKE AND NATURAL HAZARDS PROGRAM DIVISION

Mr. BECTON. Thank you, Mr. Chairman. We are pleased to appear before this session of your subcommittee to discuss our activities under the National Earthquake Hazards Reduction Program.

As Casey Stengell, said, I want to tell you something before I start talking. I appreciate the comments of Senator Danforth and Senator Lott that were made, and I want to particularly thank Senator Lott for his interest in getting the law changed so that what he has been talking about before I came to FEMA in the mid-eighties no longer would occur. Anybody could step in and FEMA would pick up the tab for it, and then we will figure out later as to who does what to whom.

As Lacy Suiter has already said, this has been a very busy week for those of us who are involved in earthquake preparedness. Monday I and some of my staff were with Senator Gore in Memphis when Lacy opened up the new CUSEC headquarters. It was a great dedication, done by professionals.

And of course, we were all shocked to hear about Al Gore III's tragic accident.

Wednesday we were all in this very room accompanying Big Bird as he kicked off the Earthquake Awareness Week. And today we are here.

I have with me, sir, two of my professionals: Dennis Kwiatkowski on my left, the Assistant Associate Director for Natural and Technological Hazards; and Gary Johnson, the Chief of Earthquake and Natural Hazards Program Division.

Senator ROBB. We are pleased both these gentlemen could join you.

Mr. BECTON. Thank you, sir.

I would like to submit my prepared remarks for the record and briefly comment on questions that were included in your invitation to testify.

Senator ROBB. Your entire testimony will be included in the record, and we appreciate your brevity in summarizing your statement.

Mr. BECTON. Thank you, sir.

Let me state at the offset that FEMA is opposed to S. 629 as drafted, and this in my judgment is not a turf issue from our point of view.

Ever-increasing earthquake probabilities and recent events such as the tragedy in Armenia have put this nation on notice. The NEHRP has clearly made progress under FEMA's leadership over the past decade. The impressive accomplishments made by all of the program agencies—FEMA, USGS, National Science Foundation, and the NIST—have been documented in the annual reports to Congress and recent NEHRP five-year plan which I submitted to the Congress in 1988.

However, if we are to avoid a tragedy here, effective earthquake hazard mitigation must become part of the national agenda. All of FEMA's activities under the NEHRP support applications and earthquake hazard mitigation. I will highlight some of the contributions FEMA is making in the mitigation of the earthquake hazards in the eastern and central United States.

Armenia vividly reinforced the old saying: Earthquakes do not kill people; buildings do. And I might add that, as the former Director of the Office of Foreign Disaster Assistance, I had a first-hand chance to see what could happen in Santiago, Chile, in 1985 and in Mexico City in September of that same year.

The long-term solution to the nation's earthquake problems rests with how well our buildings are designed and constructed to resist earthquakes. FEMA has developed and is disseminating a substantial number of nationally applicable and widely backed design and construction resource documents.

These include a comprehensive set of seismic building provisions and a guide for design professionals on how to apply them. Also, we have prepared materials targeted specifically at special audiences, like state and local decisionmakers and developers.

A similar program aimed at existing hazardous buildings is also well under way. FEMA is funding a project at The Citadel in Charleston, South Carolina, to demonstrate the feasibility of applying the NEHRP provisions to the seismic safety needs of that locality.

We annually provide the only nationwide funding to states to develop a comprehensive capability to deal with the earthquake threat. Ten of the 17 states receiving earthquake funds are in the eastern and central part of the United States.

FEMA has been the sole Federal funding source to support the Central U.S. Earthquake Consortium and the New England Seismic Advisory Council. These groups are addressing the complex multi-state issues which must be resolved to achieve effective earthquake preparedness, response, and mitigation in those geographical areas.

The results of FEMA's funding to states were summed up best in California by the Executive Director of SCEPP, during a recent FEMA state forum when he said: "You know, now I really feel that I am part of a truly national earthquake program.'

FEMA is planning and coordinating a Federal capability to respond to a catastrophic event. The centerpiece of this effort is the Plan for Federal Response to a Catastrophic Earthquake, signed by some 26 agencies and departments here in Washington.

A major exercise of this plan will occur this August in California, and hopefully we can answer some of the questions that have been asked this morning as to what if. A similar exercise for the central U.S. is planned for the future.

FEMA has developed and delivered training courses and workshops for public works, health care, emergency management, and design professionals to ensure that emerging knowledge is applied.

Approximately 2.2 million copies of FEMA's design handbooks, planning guidance, school curriculums, and self-help materials have been distributed free of charge.

In recognition of FEMA's statutory responsibility in insurance and mitigation, FEMA has under way a major study to identify feasible earthquake loss reduction provisions that can be incorporated into a national insurance or reinsurance program involving the Federal government and the private insurance industry. We believe any such insurance program must include mitigation.

What I have just laid out establishes a solid track record of accomplishments and activities in earthquake mitigation, which was also recognized by the Expert Review Committee. Furthermore, this has been accomplished under an annual budget of $6 million.

I would now like to focus briefly on Senate Bill S. 629. FEMA is supportive of the rationale behind 629, which is to have the NEHRP place greater emphasis on applications and earthquake hazard mitigation. However, we oppose the transfer of the lead agency responsibility, especially as a means to carry this out.

Leading the NEHRP is a difficult task. The Act defines lead responsibility primarily as coordinating, reporting, and planning. I believe FEMA has been successful in performing these responsibilities, and the level of cooperation between agencies in these areas has increased.

As FEMA has grown in this role, we have begun to incorporate elements of management, a desired outcome of S. 629, into these requirements, such as establishing the Expert Review Committee, requiring objectives and milestones in a NEHRP five-year plan, and reporting in accordance with this plan in the annual report.

Furthermore, I believe that as an agency we are in a unique position to lead the NEHRP into the next phase of the program, given the appropriate tools. After all, gentlemen, the third word in my agency's title is "management,' and our motto still is "Service in peace and war.'

The objectives which FEMA will be pursuing to accomplish this are included in my written report. We believe Congress can play a role in achieving this goal as well. As we move towards reauthorization of the NEHRP in 1990, I would encourage the Congress to work with us to take a thorough look at the entire program, help strengthen the lead role, and help us identify the ways and resources needed to emphasize earthquake hazard mitigation.

As the Director, I am here to tell you that FEMA is committed to the NEHRP and I believe that continued leadership of this program is part of that commitment.

Thank you, sir, for the opportunity to make this statement.

[The statement follows:]

STATEMENT OF HON. JULIUS W. BECTON, JR., DIRECTOR, FEMA

Mr. Chairman, I am pleased to appear before this session of the Committee on Commerce, Science and Transportation, Subcommittee on Science, Technology and Space, to discuss FEMA's activities under the National Earthquake Hazards Reduction Program (NEHRP).

I believe the NEHRP is at a critical juncture. Ever increasing earthquake probabilities and recent events, such as the tragedy in Armenia, have put this Nation on notice. Short of war a catastrophic earthquake may be the most devastating event this country will face.

If we are to avoid a tragedy here, effective earthquake hazard mitigation must become part of the National agenda.

The NEHRP has clearly made progress under FEMA's leadership over the last decade. The impressive accomplishments made by all the NEHRP agencies, FEMA, the U.S. Geological Survey, the National Science Foundation and the National Institute of Standards and Technology, have been documented in the Annual Reports to Congress and the recent NEHRP 5-Year Plan which I submitted to Congress in 1988.

However, more aggressive leadership and greater emphasis on applying what we know to effect earthquake hazard mitigation is indeed necessary if the NEHRP is to be successful.

My testimony will respond to the questions included in your invitation to testify. However, I would like to state, at the outset, FEMA is opposed to S. 629.

All of FEMA's activities under the NEHRP support applications and earthquake hazard mitigation. I will illustrate this by highlighting for you the contributions FEMA is making to mitigate the earthquake hazard in the eastern and central United States.

Armenia vividly reinforced the old saying, "Earthquakes don't kill people, buildings do". The long-term solution to the Nation's earthquake problem rests with how well our buildings are designed and constructed to resist earthquakes.

FEMA's active and aggressive program of seismic design is the cornerstone of our efforts to mitigate the death and destruction caused by earthquakes.

This program has developed and is disseminating a substantial number of nationally applicable and widely backed design and construction resource documents. These include a comprehensive set of seismic building provisions (NEHRP Provisions) and a guide for the design professionals on how to apply them. Also, we have prepared materials targeted specifically at special audiences, like State and local decisionmakers and developers. A similar program aimed at existing hazardous buildings is also well underway. FEMA is thus making a significant contribution to improving the seismic safety of the Nation's new and existing building stock.

Achieving a satisfactory level of building seismic safety throughout the Nation is an enormous challenge but it is particularly formidable in the

eastern and central United States where a recognition of the risk is low and where most of the buildings have been constructed without seismic considerations.

To help meet this challenge, FEMA's 1988 Edition of the NEHRP Provisions for New Buildings, prepared by the Building Seismic Safety Council, introduces new maps developed by the USGS and a design approach that provide a more precise and higher definition of the seismic risk in these regions of the country.

FEMA is also funding the Citadel in Charleston, South Carolina, to demonstrate the feasibility of applying the NEHRP Provisions to the seismic safety needs of this locality. This project is being conducted in such a way that it can be replicated in communities having comparable seismic risk.

State and local governments bear the ultimate responsibility for protecting lives and property and must play a primary role in earthquake hazard reduction.

For this reason, FEMA annually provides the only nationwide funding to States to develop a comprehensive capability to deal with the earthquake threat. These funds are provided to the State agency the Governor has designated as responsible for developing, promoting, and implementing effective State-level earthquake hazard mitigation programs.

Ten of the 17 States receiving earthquake funds are in the Eastern and Central United States.

This funding support has enhanced the public's awareness of the earthquake threat (a significant challenge east of the Rockies), stimulated earthquake specific preparedness and response planning initiatives, and is laying the ground work for long-term mitigation activities.

Of particular note are the earthquake loss studies supported by this funding for the Boston, Massachusetts and Charleston, South Carolina, metropolitan areas.

Because earthquake loss studies are an important and necessary prerequisite to any comprehensive earthquake program, FEMA has also conducted a loss study for six cities in the Central United States. This study was based on a scenario earthquake developed by the USGS. In addition, a similar study is underway for St. Louis.

FEMA has been the sole Federal funding source to support the Central United States Earthquake Consortium (CUSEC) since its incorporation in 1984. CUSEC is addressing the complex multi-state issues which must be resolved to achieve an effective level of earthquake preparedness and hazard mitigation in the vulnerable central Mississippi Valley.

FEMA is also the sole funding source to the New England Seismic Advisory Council, an organization that is beginning to address the seismic threat in the Northeast.

The results of FEMA's State financial assistance program can best be summed up by a comment made by a Californian during a recent forum hosted by FEMA to exchange information on the various State earthquake activities. After having listened to other States' present their activities, he remarked, "You know, now I really feel that I'm part of a truly National (earthquake) program".

While we as a Nation strive to achieve a seismically safe built environment, it is equally important that a response capability be developed at all levels of government to effectively cope with the inevitable earthquake.

As our State counterparts are developing their earthquake response plans, FEMA is planning and coordinating a Federal capability to respond to a catastrophic event. The centerpiece of this effort is the Plan for Federal Response to a Catastrophic Earthquake. This Plan involves some 26 Federal Departments and Agencies who have made a commitment of expertise and significant resources to support FEMA when the response is needed.

FEMA is presently expanding its Federal Response activities beyond the boundaries of the western risk areas where, out of necessity, the primary focus has been. FEMA expects to conduct a tabletop exercise of the Federal Plan in the central United States in 1990 and a full scale exercise, in the 1992-1993 timeframe. A major exercise of the Plan will occur in August of this year in California. This exercise will include participants from across the Nation.

FEMA has developed and delivered training courses and workshops for public works, health care, emergency management, and design professionals to insure that emerging knowledge is applied.

These courses have been delivered throughout the Eastern and Central United States and have been very well attended by professionals in those areas.

Similarly, the need for the publications that now comprise our "Earthquake Hazard Reduction Series" has been impressive. Approximately 2.2 million copies of these publications have been distributed free of charge. The series now contain over 50 publications, handbooks, and guidance documents which address a broad range of planning, preparedness, and mitigation subjects.

We are particularly proud of the demand for our Guidebook for Developing a School Earthquake Education Safety Program and our Teachers' Package on Earthquake's, endorsed by the National Science Teachers Association, both of which are designed to reduce the vulnerability of the Nation's school population.

What I have just laid out establishes a solid track record of accomplishments and activities designed to help place earthquake hazard mitigation on the National agenda.

I think this record becomes even more impressive when one realizes that these activities have been accomplished under an annual budget of approximately $6 million.

FEMA's record was recognized by the Expert Review Committee. They concluded that FEMA was the appropriate agency to take the lead in implementing earthquake mitigation actions.

There is another significant factor to note when we talk about an increased emphasis on mitigation. I am talking about the issue of earthquake insurance.

The insurance industry is continuing its efforts to introduce legislation which would establish a Federally secured program of earthquake insurance. I have at FEMA, through the Federal Insurance Administrator, advised the industry that any such insurance program must be linked to and contain loss reduction measures designed to mitigate the earthquake hazard.

While we realize such a program may not be imminent, FEMA recognizes its statutory responsibilities in insurance and mitigation and has undertaken a major study to identify feasible earthquake loss-reduction provisions that can be incorporated into a national insurance or reinsurance program involving the Federal government and the private insurance industry. We have done this because we believe that the advent of an earthquake insurance program could significantly impact the means by which earthquake hazard mitigation is accomplished throughout the Nation.

I would now like to focus on Senate bill S. 629.

FEMA is supportive of the rationale behind S. 629, which is to have the NEHRP place greater emphasis on applications and earthquake hazard mitigation. However, we oppose the bill because neither the transfer of the lead agency responsibilities nor the other parts of the bill appear necessary.

The Earthquake Hazards Reduction Act, as amended, established a comprehensive, multi-agency program of scientific and engineering research, mitigation, preparedness and response planning and public education. It combined the research programs of the USGS, NSF and NIST with the implementation programs of FEMA and designated FEMA as lead agency. The partnership of the four agencies in meeting the urgent needs of the Nation for earthquake hazards mitigation has been effective and should continue.

A good example of the cooperation among the NEHRP agencies is a draft Executive Order on Seismic Safety, which FEMA and the other NEHRP agencies developed, to establish a minimum level of seismic safety for Federal and Federally assisted or regulated new building construction nationally and set a much needed example for emulation by state and local governments and the private sector. This latter point is particularly relevant in the Eastern and Central United States. The Executive Order has been sent to OMB and is being formally reviewed by all affected agencies.

Leading the NEHRP is a difficult task. The Act defines lead responsibilities primarily as coordinating, reporting and planning. I believe FEMA has been successful in performing these responsibilities and the level of cooperation between the agencies in these areas has increased. As FEMA has grown in this role, we have begun to incorporate elements of management into these requirements. For example:

Establishing the Expert Review Committee to provide consensus advice to the NEHRP agencies on program priorities.

Providing to the Congress detailed milestones and objectives for the NEHRP agencies in the 5-Year Plan for 1989 - 1993; and

Modifying the Annual Report to Congress to document progress against the Program's first 5-Year Plan.

In reviewing S. 629, we noted that it adds the requirement for a high level interagency committee analogous to the existing Policy Coordinating Group. It also calls for establishing a formal Advisory Committee, which FEMA had already included as an objective in the NEHRP 5-Year Plan. We do not believe that these additions to the Act are necessary.

We believe that the good level of cooperation among the agencies makes the other parts of S. 629 unnecessary.

Furthermore, I believe that as an agency we are in a unique position to lead the NEHRP into the next phase of the program.

Our goal for this phase will be to achieve a measurable increase in implementation and adoption of earthquake hazards mitigation throughout the nation.

To accomplish this, FEMA will work with the other principal agencies to set as immediate objectives the following:

(1) Further our efforts to apply what has been learned while continuing the critical research needed to enhance our understanding of the earthquake phenomena and the reaction of the built environment to this phenomena.

(2) Work with the diverse elements of the earthquake community to develop a consensus on the priorities of the NEHRP by building on the consensus achieved by the Expert Review Committee. An Advisory Committee and a national earthquake policy workshop could provide forums to accomplish this.

(3) Work with the States to create a network to support and advance earthquake mitigation techniques at both the State and local level possibly through creation of an Association of State Earthquake Planners.

(4) Accelerate our efforts, especially in the East and Central U.S. to inform, educate and motivate the citizenry to actively participate in reducing the earthquake threat. We plan to continue using

nationally well-known figures such as Big Bird so that we can get the earthquake message across to people who would not necessarily be concerned.

(5) Provide greater opportunity for the private sector to become an integral part of earthquake hazards mitigation. One suggestion FEMA will be exploring is creation of an ongoing Business-Federal partnership for earthquake research.

We believe Congress can play a role in achieving this goal as well. As we move toward reauthorization of the NEHRP in 1990, I would encourage the Congress to work with us to take a thorough look at the entire Program, not only the lead role, and help us identify the ways and resources needed to emphasize earthquake hazard mitigation.

I believe each one of us has a moral responsibility to do our best to prevent a tragedy like Armenia from happening in the U.S. I, as Director of FEMA, am here to tell you that FEMA is committed to the NEHRP and I believe that continued leadership of the program is part of that commitment.

Thank you Senators for your time and attention.

Senator ROBB. Thank you, Mr. Becton.

Senator Danforth is going to depart at this point. Normally, Dr. Peck, if you would excuse us for a minute, we would take your testimony and then take questions. But in order to permit Senator Danforth to ask his questions, please proceed, sir.

Senator DANFORTH. Mr. Chairman, I really appreciate that.

General, I have a prepared question. I am not going to ask it of you. I am going to read it to you, though, and I am going to ask you just for a one-word answer. And that is: Could you respond in a satisfactory way to this question? That is the question: Could you respond, yes or no, in a satisfactory way to this question?

If an earthquake were to occur tomorrow in St. Louis, what is the first thing FEMA would do? Who would the Mayor of St. Louis call? What if communication lines were down? Would officials in neighboring states know what to do? Who would notify necessary medical and rescue personnel and arrange for them to get to the state?

How quickly would FEMA be on the scene? Who would be in charge of the rescue efforts? How would rescue equipment and personnel get to the scene? Does FEMA have a plan for cleanup and recovery after the emergency?

Now again, I am not going to ask you to go through that. It would take forever. But I simply want to ask you, could you give a satisfactory and affirmative response to that series of questions?

(The following information was subsequently received for the record:)

QUESTIONS OF SENATOR DANFORTH AND THE ANSWERS THERETO

Question. If an earthquake were to occur tomorrow in St.Louis, what is the first thing FEMA would do?

Answer. If a catastrophic earthquake were to occur in St.Louis, FEMA would implement the Plan for Federal Response to a Catastrophic Earthquake. This Plan was signed on April 15, 1987 by the heads or designated representatives of 25 agencies.

After the occurrence of a catastrophic event, a Presidential major disaster declaration would be made as soon as requested by the Governor, the Plan would then be implemented. With implementation of the Plan, agencies with responsibilities under the Plan would immediately deploy to the affected area to conduct lifeasaving, life and property protecting response activities in support of local and State efforts. FEMA would deploy a Federal Coordinating Officer to the scene to coordinate the overall Federal response activities with the State. FEMA would also convene the interagency Catastrophic Disaster Response Group (CDRG) in Washington, DC to coordinate national- level support for activities in the field.

Question. Who would the Mayor of St. Louis call?

Answer. The Mayor would establish contact with the State and the Governor through the Missouri State Emergency Management Agency (SEMA), which coordinates emergency response activities for the State. The City of St. Louis and the State of Missouri have emergency operations plans which outline such procedures. The Agency maintains liaison with the FEMA Regional Office in Kansas City to coordinate State disaster response activities with the Federal Government.

Question. What if communication lines were down?

Answer. The State has identified backup resources for emergency communications, including radio links. FEMA also has a range of communication resources that could be utilized in the event that local and State resources area not available.

Question. Would officials in neighboring states know what to do?

Answer. In addition to individual State planning efforts for response to a catastrophic earthquake, the seven States (Missouri, Arkansas, Illinois, Indiana, Kentucky, Tennessee, and Mississippi) which could be affected by a central U.S. earthquake along the New Madrid fault are working together to develop joint response and mutual aid procedures which would provide resources throughout the impacted area.

Question. Who would notify necessary medical and rescue personnel and arrange for them to get to the State?

Answer. Under the Plan, eleven emergency support functions have been identified to provide Federal response assistance to support State and local efforts. One of these functions is Health and Medical Services The Department of Health and Human Services has the lead planning and response role for this function. Another function is Urban Search and Rescue for which the Department of Defense has the lead. These two departments would immediately upon notification by FEMA deploy to the scene for immediate response activity.

Question. How quickly would FEMA be on the scene?

Answer. Upon implementation of the Plan, FEMA would establish a temporary Disaster Field Office in the Kansas City Regional Office to coordinate lifesaving and lifeprotecting efforts by of Federal agencies in support of local and State efforts at the scene. FEMA, in conjunction with the General Services Administration (GSA), within 24 hours would set up a Disaster Field Office in the affected area from which Federal agencies would provide coordinated response assistance.

Question. Who would be in charge of the rescue efforts?

Answer. A Federal Coordinating Officer will be appointed by the President to coordinate overall Federal disaster response efforts with the State Coordinating Officer. The operational control of search and rescue efforts under the Federal Earthquake Response Plan is the responsibility of the Department of Defense with the support provided by FEMA and other designated Federal agencies as prescribed in the Plan.

Question. How would rescue equipment and personnel get to the scene?

Answer. Rescue equipment and personnel would be deployed by the fastest available means, including civilian or military air transport, and with transport vehicles at the site to get these resources to the critical impacted areas.

Question. Does FEMA have a plan for cleanup and recovery after the emergency?

Answer. The Plan addresses the immediate response activities required for the initial 30 days after the catastrophic incident. Once immediate response needs have been met, normal disaster recovery procedures would be in effect, to include cleanup and recovery activities.

Mr. BECTON. Sir, if I may, I can give you a qualified yes. I say that be-

cause FEMA is the focal point within the Federal government for all types of emergencies of that nature.

Senator DANFORTH. So we would be ready to go?

Mr. BECTON. Yes, sir. I say qualified. I would certainly have to have more time than one or two sentences to respond to that.

As an example, the national disaster medical system, NDMS, which has not been mentioned, at least to my knowledge, this morning, has set aside 100,000 beds to deal with a major disaster of that type. They have identified doctors, have identified hospitals, have identified teams that are in some part ready. We will be better prepared a year from now.

But I can give you a specific answer after the exercise, Response '89, in August of this year, when we are going to test out those very things you asked about.

Senator DANFORTH. Thank you very much.

Senator ROBB. Thank you, Senator Danforth. And in that regard, I suspect that the Senator would be reassured to have the specifics in writing to that question if it were appropriate, so that he could relieve the anxiety of all the citizens of St. Louis that he has now created.

Thank you very much, Senator Danforth.

Dr. Peck, we would now be pleased to hear from you, sir.

STATEMENT OF DR. DALLAS L. PECK, DIRECTOR, UNITED STATES GEOLOGICAL SURVEY; ACCOMPANIED BY DR. ROBERT L. WESSON, CHIEF, OFFICE OF EARTHQUAKES, VOLCANOES AND ENGINEERING

Dr. PECK. Thank you, Senator. If it is all right with you, I would like to submit my written testimony for the record.

Senator ROBB. We would be pleased to receive it in total and it will be included in the record.

Dr. PECK. I will just summarize briefly.

I am accompanied by Dr. Robert Wesson, who heads our Office of Earthquakes, Volcanoes and Engineering.

Senator ROBB. Dr. Wesson, we are delighted to have you with us as well.

Dr. PECK. We in the Geological Survey are proud to be part of the National Earthquake Hazard Reduction Program together with FEMA, the National Science Foundation, and the National Institutes of Standards and Technology. Reducing the hazards from earthquakes is an important objective for the nation, not just in California but in many parts of the Nation, including the central and eastern United States.

The National Earthquake Hazards Reduction Program is particularly important to the Geological Survey because it presents a significant opportunity for us geologists, geophysicists, and engineers to apply what we have learned and are learning about the active processes that shape our earth and benefit the people of the Nation.

I have been involved in earthquake hazard activities for some 25 years. Twenty-five years ago I was at the Volcano Observatory in Hawaii studying earthquakes and volcanoes. Twenty years ago I had a position very similar to that of Dr. Wesson, supervising programs in geochemistry and geophysics, including earthquake programs in the U.S. Geological Survey.

Over that period of time and particularly in the last decade, we have learned a significant amount. We have made major accomplishments in our understanding of earthquakes and how to reduce the hazards of earthquakes.

Some of those highlights include the fundamental concept of plate tectonics, a discovery spurred by the research funded by the National Science Foundation. That discovery provides a conceptual framework for understanding the origin of earthquakes, particularly in the western United States.

Earthquakes in the eastern United States are still not well understood. Significant progress has been made though in identifying the geologic structures responsible for the 1811 and 1812 Mississippi Valley earthquakes, a repeat of which today would indeed have extremely serious consequences for the Nation, as Dr. Ketter pointed out.

We have also improved our understanding of the origin of earthquakes in other parts of the eastern United States, including those in Giles County, Virginia. In fact, just this last week we released a report prepared in cooperation with Professor Bollinger of VPI on the Giles County, Virginia, seismic zone.

We have learned that both in the New Madrid area and in Giles County we have very ancient faults that were active perhaps 600 million years ago, that have been reactivated under current stress regimes that is very different from ancient stresses.

Detailed geologic studies in California using a new technique called paleoseismology have provided a record of the times and occurrence of large earthquakes on part of the San Andreas fault extending back thousands of years to the time of the birth of Christ.

These data, combined with modern probability techniques, have been used to develop quantitative estimates of the probability of major earthquakes along the San Andreas fault over the next 30 years, and we have released a publication prepared in connection with our committee on earthquake probabilities that details the recurrence intervals of earthquakes along the San Andreas and adjacent faults.

Significant advances have been made in understanding the physics of earthquakes. The earthquake prediction experiment under way near Parkfield, California, provides an important opportunity to advance the science of earthquake prediction and, through working with the California Office of Emergency Services, to learn how this emerging technology can be used effectively for the public good.

In connection with the experiment, we have come up with sort of a decision tree for predicting the Parkefield earthquakewhich leads us to work with the State Office of Emergency Services and the county emergency services personnel.

We are particularly proud of the accomplishments achieved by the Geological Survey, FEMA, and particularly state and local agencies to translate into effective hazards reduction measures what is being learned about earthquakes and their effects.

Just last week, for example, a workshop was held in Portland, Oregon, attended by about 250 state and local officials, emergency service experts, planners, geologists, and engineers to discuss earthquake hazards reduction measures in the Pacific Northwest.

I think a particularly important recent activity, in which we are participating, is the formation for the 1990's of the International Decade of Natural Disaster Reduction, with leadership provided by the National Academy of Sciences, and with participation by the Office of Foreign Disaster Assistance of AID.

This program has the potential of transferring knowledge and technology from other disaster areas, like tornadoes or forest fires, to the area of volcanoes and earthquake hazards.

In conclusion, we are very pleased with the progress of the National Earthquake Hazards Reduction Program, but a great deal remains to be done. We support the recommendation of the FEMA Expert Review Committee in the very fine report that they produced that additional emphasis must be placed on implementation, but that considerable research is still required if the Nation is to achieve an acceptable level of earthquake hazard reduction.

Indeed, I think the program needs strengthened leadership and I think the comments by some of the earlier witnesses that we will make more progress if more resources are applied to the program, has to be the starting point.

Thank you very much, Senator.

[The statement follows:]

STATEMENT OF DALLAS L. PECK, DIRECTOR

U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

UNITED STATES SENATE

APRIL 7, 1989

Mr. Chairman, I am pleased to appear before this committee to participate in a hearing on the National Earthquake Hazards Reduction Program (NEHRP). Earthquakes are devastating in their potential for causing great sudden loss. They have struck and will again strike urban centers throughout the United States causing great physical and societal impacts over a broad geographic region. Without adequate understanding of the hazard, prediction capability, preparedness and mitigation measures in place, an urban center faces the threat of damage and destruction of buildings and lifeline systems, as well as death, injury, homelessness, and joblessness for the populace. Economic losses can easily reach into the billions of dollars and seriously impact our national security.

The urgent need to address this national threat was recognized by the Congress in 1977 with the creation of the National Earthquake Hazards Reduction Act which established a focused program to accelerate progress in research on the earthquake phenomenon, the development of technology to identify the earthquake hazard, and the implementation of loss-reduction measures that would mitigate or reduce the earthquake hazard throughout the United States. It was the intent of Congress when it first passed the Earthquake Hazards Reduction Act that four principal agencies with distinctly different capabilities and mandates would be given roles in the program to address specific aspects of the National Earthquake Hazards Reduction Program, as follows:

- National Science Foundation (NSF) for fundamental earthquake studies, earthquake engineering research, and social science research;
- U.S. Geological Survey (USGS) for earthquake potential, prediction, monitoring, and risk assessment;
- Federal Emergency Management Agency (FEMA) for earthquake preparedness, education, and response; and the
- National Institute of Standards and Technology (NIST) for earthquake building research for codes and standards.

Of these four, FEMA was identified in the Act, as amended in 1980, as the agency with the lead responsibility for the program and, in that role, has served the Nation in the implementation of the contributions from each of the principal agencies.

We believe that the provisions of S. 629, which alter the current interagency arrangements in the management of the National Earthquake Hazards Reduction Program, are unnecessary. The Earthquake Hazards Reduction Act was reauthorized only last year and the program appears to be working. For this reason, we oppose changes in the administration of the Act at this time.

Some of major accomplishments in the first 10 years of the program include:

- Major changes in earthquake-resistant design in the Western United States and the beginning of changes in the Eastern United States;
- Major revisions in building codes, standards, and practices to incorporate new knowledge on earthquake ground shaking and the behavior of soils, construction materials, and lateral force-resisting systems subjected to these loads;
- Recognition of previously unknown or poorly known seismogenic zones of the United States and characterization of the earthquake potential for those zones;

- Improved understanding of earthquake occurrences on active fault systems by applying new computer, laboratory, and field instrumentation technologies;
- Application of paleoseismicity research to several earthquake-prone regions of the United States to determine prehistoric seismic events and their recurrence intervals;
- Development of a national and several regional seismic monitoring networks to inform the public of current earthquake activity;
- Improved national and regional maps showing ground-shaking and ground-failure hazards, as well as loss estimations in selected urban areas;
- Siting and deployment of the first earthquake prediction experiment in the United States, on the San Andreas fault, California;
- Broader and more effective training of State and local government emergency response professionals at the National Emergency Management Training Center;
- Increased understanding and awareness by professional engineers and planners of the nature and characteristics of the earthquake threat in the Intermountain Seismic Belt, the Pacific Northwest, and the Eastern United States where little was known a decade ago;
- New knowledge about and application of retrofitting and repair of existing structures to better survive projected levels of ground shaking as well as the development and application of energy dissipation systems;
- Establishment of publicly based earthquake information and preparedness projects in many States; none existed a decade ago;
- Initiation of a national emergency management planning process involving researchers and practitioners to deal with catastrophic earthquakes throughout the nation;

- Establishment of the National Center for Earthquake Engineering Research (NCEER) at the State University of New York in Buffalo, New York; and
- Improved understanding of physical, social, and economic impacts of earthquakes gained from organized post-earthquake investigations.

On December 7, 1988, world attention was focused on the catastrophic effects of a major earthquake when a magnitude 6.9 earthquake struck the Soviet Republic of Armenia, leaving an estimated 60,000 dead, 510,000 homeless, and $16 billion in reconstruction costs. Cities like Spitak (located in the epicentral region) and Leninakan (25 miles from the epicenter) suffered heavy damage with many schools, hospitals, factories, and apartment buildings collapsing and lifeline systems rupturing and failing. The long-term impact of this disaster still cannot be estimated.

In response to a request from the Soviet Union, a team of U.S. scientists and engineers, led by the U.S. Geological Survey, was dispatched to Armenia. The team found that the earthquake resulted from thrusting movement on a fault which broke the Earth's surface along a 5-mile rupture plane. This fault was not unlike many that exist in the United States. The earthquake's greatest damage occurred in modern reinforced concrete buildings designed and constructed in the 1970's which, when they collapsed, fell straight down, either crushing or suffocating occupants in compact piles of rubble. American engineers who have observed and analyzed the factors contributing to the catastrophe have stated that many of these factors exist in earthquake-prone areas of the United States.

If one asks the sobering question as to whether a similar disaster could occur today in the United States the answer would probably be "yes" in several parts of the Nation, because key mitigation strategies of the NEHRP have not been fully implemented. However, if the Nation continues to push vigorously

ahead with the NEHRP, we believe that the probability of an Armenia-like disaster in the United States can be drastically reduced. We need, through basic research, to continue our efforts to understand and anticipate earthquakes and earthquake damage, and then to translate those research results into practical applications. We are confident that the four principal agencies, working together, can achieve this goal in all parts of the country, East and West. For this reason, we oppose enactment of S. 629.

Furthermore, the United States is now being challenged to join with other nations throughout the world in concerted actions to make the 1990's an International Decade for Natural Disaster Reduction. The contributions from existing programs, such as the National Earthquake Hazards Reduction Program, will be of fundamental value in carrying out the role that the United States plays in the International Decade.

The USGS has been proud to be one of the four principal agencies of the National Earthquake Hazards Reduction Program. We believe that the accomplishments of the second decade of the NEHRP will meet the needs of the Nation and satisfy the concerns of Congress.

This concludes my formal statement, Mr. Chairman. I will be happy to respond to your questions.

Senator ROBB. Thank you very much, Dr. Peck, for your testimony.

Just a couple of questions here, unless other colleagues join us. I guess I will start with you, Mr. Becton. You indicated that it was difficult to provide the lead agency status for NEHRP, and there has been other discussion about improving management and coordination. I do not recall anything specific in your testimony that related to that function.

Are there specific areas where the management could be improved in your judgment, and if so could you allude to those for us?

Mr. BECTON. Yes, sir. I think just the inclusion of that term "management" in the law would help, which is proposed in 629. It goes beyond the coordination and the planning. One of the things that we in FEMA——

Senator ROBB. Is this a lack of authority in the chain of command? Is that what you are suggesting?

Mr. BECTON. No, I think the law could be strengthened to spell out what they mean by the management role. But we are not fighting for any type of turf from that standpoint. But as has been said many, many times, and we have in place a way to coordinate with the other agencies.

We propose in the five-year plan that we would do certain things. The organizational structure should be looked into. Even the subject of the commission I heard earlier would be evaluated to see if that would give us, "us" being the entire NEHRP, a better handle on that.

If I may ask one of my colleagues for a better response or for an additional comment, then we might get further light into it. Dennis?

Mr. KWIATKOWSKI. Well, there is only a couple of things I guess I would add, sir, and that is that the Congress could work with us to clarify the agency's roles with regard to the NEHRP and perhaps improve the term "management,' as the Director has said.

We would like to see a better relationship to priorities and the requiring of accountability in that regard. Also perhaps a separate authority for the lead agency responsibility and a separate authorization and appropriation for the lead agency might be very effective.

We do believe that we are going to be looking at the idea of a commission. It is part of the five-year plan and FEMA has it as its goal this year to begin investigating the use of that kind of a commission.

Senator ROBB. It would seem to me that clarification of some of those roles and responsibilities is an inevitable result of this particular hearing. If there is any consistent theme that has occurred, it has to do with that particular element of it.

I am just curious. Mr. Becton, less than one percent of your agency's budget is directed to activities in this area. Have you had an opportunity previously to personally appear before some of the meetings on earthquakes, or have key staff members appeared to represent you in some of those hearings?

Mr. BECTON. Before OMB or before a committee of the Senate or the House?

Senator ROBB. Well, I would ask both of those questions, and in addition ask about other meetings involving NEHRP, generally.

Mr. BECTON. We have 25 subcommittees that have oversight over FEMA, which sort of adds to—it makes our day. I have appeared with my staff before the House Appropriations Committee, in which we made a presentation for our annual budget. Recognizing that in this period of deficit financing we are going to have to share, like other Federal agencies. We have been straightlining our requests since fiscal year 1988, I believe.

Prior to that we have come in asking for more funds and we were not permitted to go beyond OMB with that request.

Senator ROBB. Have you been personally involved in this activity?

Mr. BECTON. Yes, sir, I have.

Senator ROBB. There has been a discussion that has not been terribly formal throughout the morning about money or the lack thereof, and where it should come from. Since you represent two of the four agencies directly involved in this particular effort, would you care to give any specific numbers on the funding that is required to do what you believe to be the mission that has been charged to you under the current circumstances or the inadequacy thereof?

Mr. BECTON. Sir, you want to start?

Dr. PECK. Well, I will say I agree with the earlier witnesses that, for all the agencies involved in this program, that with the constant level of funding over the last 10 years, our ability to conduct research and carry out the other program functions has been degraded, and that the current level of funding is, in actual terms, only 50 or 60 percent of what it was years ago.

It is a very large problem, and if you look at the casualties and the damages that would be caused by a major earthquake and what we can do to reduce those damages by expeditious work by all the agencies involved, then I think a greater level of funding would be worthwhile.

That statement is very easy to make when you are not mentioning where the additional funds are going to come from or asking you to raise taxes or something like that. It is a very difficult issue, Senator.

Senator ROBB. Mr. Becton, you indicated in response to Senator Danforth's question that you would give a qualified yes to his question about your ability to at least respond to his list of questions.

Some might interpret that response to mean that with current funding and current resources and current responsibilities, that you could carry out the mission that has been assigned to you. What needs would you suggest to us are simply going unmet because of a lack of funding either now or prospectively?

Mr. BECTON. Sir, I was responding to the Senator's question as to in the form of a recovery to an actual earthquake and not from the standpoint of NEHRP itself.

Senator ROBB. In other words, NEHRP itself is adequately funded, you simply need a contingency to replenish resources that would be drained down in the event of an actual response?

Mr. BECTON. We could always use more money.

Senator ROBB. Well, I know everybody could always use more money.

Mr. BECTON. But I was trying to differentiate between the NEHRP provisions and the recovery from an earthquake itself.

Senator ROBB. There was some testimony earlier on, though, that there were not adequate resources devoted to the managerial role, much less to the long term drawdown on resources. Am I to understand from your answer that the current resources are adequate for the administrative and managerial role and that the need would be to provide the immediate response to the tragedy that occurs when a major earthquake takes place in a populated area as the responses to questions by Senator Lott and others indicated.

Mr. BECTON. Mr. Chairman, may I refer that to Gary Johnson, who has been living with this problem for many, many years. I would point out, however, that in our 50-50 cost sharing with states there are two states right now that have not signed up for that. So clearly, if they do not have the funds we are in problems just from the planning standpoint.

Gary.

Mr. JOHNSON. Thank you, Director.

Senator, I think a differentiation here has to be made clear between the financial resources that the agency is appropriated to deal with overall response as part of our inherent mission vis a vis the appropriations that are provided to us to execute our programmatic responsibilities and our lead agency responsibilities under the NEHRP. I will address the latter.

And I think we would agree with the position of the Expert Review Committee that the program has been underfunded and would, if appropriated funds, use that particular document as a guide to where to place those funds. I think the Expert Review Committee, just speaking for FEMA, was looking towards a $22 million increase over our current program of $6 million.

The question comes, what would you do with that money? Clearly, we would want to more aggressively fulfil our lead agency responsibilities—that is the subject of the hearing—by looking into ways to effectively plan the program.

However, on the other side, on our programmatic responsibilities we would clearly be delivering more moneys to state governments, local governments, than are presently provided. Only $1.5 million goes directly to support state capability building to deal with the earthquake program.

We would definitely put more money into training. It was mentioned earlier this morning, the need to provide training for urban heavy rescue. No question, that is something we are having a very difficult time squeezing out of a budget of $6 million.

One thing that is very, very, important, is the need to conduct loss estimation studies and scenarios. Senator Danforth mentioned or asked, what are the losses in St. Louis? FEMA is undertaking that particular study to get a handle on those losses.

But the Expert Review Committee indicated that at least 3 to $3.5 million should be devoted to identifying those losses. Loss estimation studies are an absolute necessity for good planning, not only at the Federal response level, but the state level and the local level.

Senator ROBB. Thank you.

Senator Lott has returned. Let me give him a chance to ask any questions he might have.

Senator LOTT. Just a comment and a couple of questions. First, Dr. Peck, let me assure you that I have the utmost and highest regard for your agency. I think you do a magnificent job and I would like for us to help you do what you presently do better and not put more burdens on you that are really not in your sphere of general interest.

Dr. PECK. Nicely said, Senator.

Senator LOTT. And any more you want to do down at the Stennis Space Center in Hancock County would be fine with me.

Senator ROBB. In Virginia we refer to that as the shad treatment.

Senator LOTT. General, we changed the law that applies to your agency a couple of years ago, I believe, right?

Mr. BECTON. The change I was talking about took place just last year.

Senator LOTT. Okay, right. And so that gave you some of that authority that you wanted that you did not have?

Mr. BECTON. That is right.

Senator LOTT. As you recall—I think you were referring to that—as a member of the other body, formerly the upper body, now the lower body, I did work on that a great deal.

Mr. BECTON. Yes, sir, I have sat and heard your comments several times.

Senator LOTT. Right. And I view your agency's role as really—I am sure it is multifaceted, but there are two general areas: what you do in advance of a disaster, in preparation for and identification of potential areas and planning and all of that sort of thing; and then the second part is how quickly you come into action and what you do after the disaster hits.

So with regard to earthquakes, I mean, I think again there are two questions. Are you now working with a variety of agencies? I mean, obviously you are, but do you feel like that you are doing enough? Do you need more direction? And what needs to be done in advance of an anticipated earthquake?

Mr. BECTON. Sir, our "modus operandi" of performing our function, are four steps: preparedness, mitigation, response, and recovery.

We have from the earthquake standpoint, as I demonstrated, a plan for the Federal response to a catastrophic earthquake, signed off by 26 departments and agencies here in Washington. That in itself is no menial task, to get that number of agencies to agree to this plan.

We are going to test this plan in California in August of this year. We are also going to have an exercise later, 1990 or 1991, to test a plan in the central part of the United States, working with the consortium there.

So we have, I believe, the plans. We have the procedures. We do not have some of the equipment. It was mentioned earlier we do not have equipment to go in to a heavy urban search and rescue mode. We do not have equipment in hand to be able to monitor and to listen for where there is someone alive inside the wreckage.

I was in Mexico City and I saw what happens when 18 stories collapse onto three. It is very difficult to dig in. You cannot bring in heavy helicopters and lift things up because you are going to force things down. You cannot bring in bull dozers.

You have to have that type of equipment that can cut through without destroying what may be inside, to get to the people who are there.

I think our building codes are moving in the right direction. As Gary was saying, we are working with the folks in the private industry to develop the building codes—what should be done.

But I think our greatest strength comes in the day to day activities that we have with the state and local governments. Every day we are dealing with the states, the local governments, in a situation of which you, and Senator Robb are aware.

When I first came on board in FEMA, we had floods down in Roanoke and also in West Virginia. We were there as soon as it was determined that help was needed. We do not have to wait to be invited in if we see a life-threatening or some other situation exists.

A long answer to your question, sir. But I think that we have the support, I think we are not wanting for any more guidance. I said before you came back that we have some 25 subcommittees that give us guidance now, so we are not looking for any more of that.

Senator LOTT. Thank you, and I appreciate the fact that you do get an awful lot of guidance. But I would rather give you guidance before the disaster than to rassle with you after the disaster.

Mr. BECTON. Sir, I think we resolved that one.

Senator LOTT. I think FEMA has a good record of getting on the job quickly. But I still have a concern about what happens after you get on the job. Why, then bureaucracy sets in, unfortunately, too much.

I would commend to you to go back—with your background, you would be interested in it and I am sure you have already done it. But go back and look at the predecessor to FEMA, Office of Emergency Preparedness.

Mr. BECTON. Yes, sir.

Senator LOTT. It was better.

Mr. BECTON. There were five predecessors to FEMA, too. That is just one of them.

Senator LOTT. Well, OEP. OEP in the late sixties worked great. One of the things, the reason why I think it was better than what you have now, it was more military in its way of thinking. Now, I am saying that. You are not saying that as a military man.

And I know about federalism. I do not want to cut the states out and I want the local governments to be involved. But I also want—when there is a disaster, I want some quick direction of a military-type precision, with ability to make a decision.

For instance, I do not understand why, just one example, why when you have a disaster—do you not have all these trailers still based over in Atlanta that I fly over every time I go in and out of Atlanta?

Mr. BECTON. We are moving those trailers, sir, to one location in Kentucky.

Senator LOTT. The point is not where they are based. The point is when a disaster hits, do not wait until you determine you need X number of trailers to start moving them. You should move a preliminary number immediately, get them in the area.

You know when you have a disaster you are going to need some trailers. But the process that you had after Elena, first of all the general attitude was, we aren't going to send them, we are going to find local available apartments, even though they might be some 26 miles away in a rural area. And by the time you got through with the bureaucracy, it was 30 days, if you got them.

Think emergency and start moving them immediately, a limited number. But the attitude ought to be, we are going to be available quickly and we are not going to go through all this long, protracted process and

become—you know, the word I just cannot get away from is "bureaucracy," and some ridiculous idea that it was all right to pick a person up that lost their home and move them 26 miles away, two towns away, and sock them in an apartment just because the apartment might be available there—just one example.

The other thing is, you do now have a clear working relationship and understanding with DOD, right?

Mr. BECTON. We have an understanding with DOD. We have a working relationship with DOD. We have an MOU with DOD. I can get from DOD whatever we need.

Senator LOTT. And then but are you going to argue with them over who pays?

Mr. BECTON. Sir, we are going to respond first and worry about who is paying later. As you said, we can come back to you, because there is not but so much money in our current disaster fund. So we are going to go out there and spend what has to be done without worrying about the dollar sign, and then come back and ask for whatever we need.

Senator LOTT. Well, I guess I could ask a lot of questions, sort of personal questions, because I have been through three of these things. But I am encouraged by your attitude and I do think that the law we passed last year hopefully will help.

And I will look forward to getting into this earthquake thing some more and working with you, and I wish you the very best, General.

Mr. BECTON. Thank you, sir.

Senator ROBB. Thank you, Senator Lott.

I am going to resist the urge, the temptation, to comment on a couple of things that were said. I would only observe the use of one word and I hope, if Mr. Bernstein is still here, that I am not improperly attributing it, but I think Senator Lott liked the word "dictate" at one point in his testimony and mentioned using the military chain of command so that you get things done. I think that you all can probably do some business together.

Mr. Becton, Dr. Peck, and your associates who came with you, we thank you for joining us this morning and for providing additional information. This obviously is a topic that is going to require follow-up. We would encourage you to provide the information that we have requested.

There may well be additional hearings on this question before we are concluded, but we thank you very much for being with us. We thank the others who are here.

And at that point, the committee stands adjourned.

[Whereupon, at 11:58 a.m., the subcommittee was adjourned.]

[The following information was subsequently received for the record:]

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
(formerly National Bureau of Standards)
Gaithersburg, Maryland 20899
OFFICE OF THE DIRECTOR

APR 12 1989

Honorable Albert Gore, Jr.
Chairman, Subcommittee on Science,
Technology, and Space
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

In response to the request made by you and Chairman Hollings on March 23, 1989, I am enclosing a statement for the record of your April 7 hearing on the National Earthquake Hazards Reduction Program (NEHRP).

If you require any additional information our Congressional Affairs Director Esther Cassidy can be reached on 975-3080.

Sincerely,

Raymond G. Kammer
Acting Director

STATEMENT OF THE

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

INTRODUCTION

Soviet Armenia's catastrophic earthquake in December, Figure 1, reminded us of the threat to lives, property, economic activity and national security posed by earthquakes. A large earthquake striking an inadequately prepared U.S. metropolitan area can cost tens of thousands of lives and tens of billions of dollars in property damages. Armenia's earthquake was reported to be its greatest in 300 years. It is sobering to note that the United States, east of the Rockies, has had five earthquakes of similar or greater magnitude in the past 300 years. None have yet occurred in the east in this century, but we are sorely vulnerable to the great losses earthquakes can cause in unprepared areas where buildings and other structures are not sited, designed and constructed to be earthquake resistant.

For instance, the insurance industry's Earthquake Project estimates that a Richter Magnitude 7.5 earthquake on the Newport-Inglewood fault north of Los Angeles (a relatively well prepared area) at midday would cause 17,000 deaths and $50 billion in insured property loss. Larger additional losses would arise from uninsured damages and interruptions in productive activities.

The National Earthquake Hazards Reduction Program (NEHRP) was mandated by Congress in 1977 to reduce the hazards of earthquakes.
The National Institute of Standards and Technology (NIST) is one of the four lead agencies of the NEHRP. Through its Center for Building Technology (CBT), NIST is tasked [1,2] to provide research and technical support for the development of improved seismic design and construction practices. NIST conducts research to obtain needed knowledge using its unique laboratory and computational facilities, provides technical support to private and governmental organizations for the development and

STATUS OF THE NEHRP

Substantial accomplishments have occurred in the eleven year history of the NEHRP. Highlights particularly relevent to the improvement of seismic design and construction practices include development of the NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings and their incorporation of probability-based seismic hazard maps for exposure times of 10, 50, or 250 years.

The NEHRP Recommended Provisions for the Development of Seismic Regulations for Buildings have been developed by the private sector Applied Technology Council (ATC) and Building Seismic Safety Council (BSSC) with financial support from the Federal Emergency Management Agency (FEMA) and the National Science Foundation (NSF), and technical support from NIST. These provisions are intended to provide the basis for the seismic safety requirements of building standards and codes used nationwide for design and construction.

The probability-based seismic hazard maps, developed by the U.S. Geological Survey (USGS), reveal to decision makers the variation within the U.S. of earthquake intensity with exposure time. In the eastern and midwestern U.S., earthquake intensity increases greatly for longer exposure time. In California the largest earthquake intensity expected in 250 years is only slightly larger than that expected in 50 years.

Trial designs have shown that seismic safety in new buildings is achieved at costs less than 2 % of construction cost. The major expense for seismic safety in new building construction is for education: for owners, designers and builders to learn how to achieve seismic safety. Then practices for seismic safety can be applied at little or no extra cost for design, construction, or operation. Earthquake catastrophies readily can be avoided for new buildings. To accomplish this, the NEHRP provisions must be incorporated in building standards and codes, nationwide, and the codes enforced.

Practices for seismic safety of new lifelines (facilities for transportation, power, communication, watersupply and sewage treatment, etc.) are less advanced, with the exception of practices for highway bridges, which have received attention by the Federal Highway Administration. Furthermore, it is more difficult and expensive to identify and correct unduly hazardous existing structures than to build for seismic safety in the first place. Much research and development effort [3,4,5] is needed to formulate and apply effective practices for the seismic safety of new lifelines and existing buildings and lifelines.

To summarize briefly, the major engineering application, development and research efforts needed to achieve seismic safety of buildings and lifelines are:

o Application of Seismic Safety Practices

- Incorporate knowledge in standards, practices and regulations.
- Educate owners, designers, builders, regulators and the public to use available practices.
- Adopt and enforce up-to-date standards and codes for buildings, lifelines and land use.
- Incorporate mitigation provisions in earthquake insurance.

o Development of Improved Seismic Safety Practices

- Assessment of seismic safety of existing buildings and lifelines.
- Cost-effective strengthening of existing buildings and lifelines.
- Safe, cost-effective practices for innovative structural systems and materials.
- Site hazards assessment and abatement.

o Research for Improvement of Seismic Safety Practices

- Site-specific definition of seismic loads
- Soil-foundation-structure interaction
- Changes of strength and stiffness with inelastic response to earthquake motions.
- Residual strength and energy absorbing capacity of "damaged" structures.
- Reliable, appropriate technologies for base isolation, energy absorption and active control of structures.
- Seismic behavior of innovative structures, systems and materials.

These are stated in this unusual order to emphasize that application and development efforts to exploit and apply existing knowledge from research should be pursued vigorously in concert with a continued, strong research effort.

Application and development of improved seismic design and construction practices should be an objective of any new legislation. NIST activities have been well coordinated with those of other agencies in the NRHRP as currently led by FEMA. Effective coordination should not be lost in any leadership change.

NIST ACCOMPLISHMENTS IN THE NEHRP

NIST has neither requested nor received additional funding to carry out its role in the NEHRP. Its accomplishments have been funded by reprogrammed, directly-appropriated (STRS) funding or funding from other Federal Agencies (OA), principally from FEMA. The funding history for NIST is shown in Table 1.

NIST accomplishments in the NEHRP are presented under the headings: improved seismic design and construction practices, post earthquake investigations, research, research needs studies and collaborative activities. In all NIST work, efforts are made to provide practices and knowledge applicable to the eastern and midwestern U.S., as well as California.

Improved Seismic Design and Construction Practices

- o 1985 and 1988 NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings.
  NIST planned the process for their development and provided the technical secretariat for their development by the Building Seismic Safety Council (BSSC). The trial designs conducted in the development have demonstrated the effectiveness and economy of the provisions for all parts of the U.S.

- o 1986 Proposed Executive Order Seismic Safety of Federal and Federally Assisted or Regulated Construction
  NIST led in the drafting, balloting and approval of the proposed executive order by the Interagency Committee on Seismic Safety in Construction (ICSSC). The order would establish a minimum, consistent level of seismic safety in Federal and Federally-assisted or regulated construction and set an example for emulation by the private sector.

- o 1987 Seismic Design Guidelines for Federal Buildings
  NIST chaired the ICSSC committee that developed the guidelines and their predecessor, the 1981 Draft Seismic Standard for Federal Buildings. The guidelines are used by Department of Energy and the Post Office and as a reference by other agencies.

- o 1982 American National Standard A58.1, Minimum Design Loads for Buildings and Other Structures
  NIST provided the secretariat for the incorporation of an up-to-date seismic zone map based on studies sponsored for NEHRP by USGS, NSF and NIST, and consistent load factors for earthquakes and other loadings based on studies by NIST. A58.1 is cited for design loads by two of the three model codes used in the U.S.

- o 1983 and 1989 American Concrete Institute Standard ACI 318, Building Code Requirements for Reinforced Concrete
  NIST serves on the standard committee which has incorporated NEHRP recommendations. ACI 318 is the national standard most widely cited in building codes.

- 1984 ASTM Standard D1586 Standard Method for Penetration Test and Split Barrel Sampling of Soils
  Incorporates NIST research to provide the test method generally used to assess the liquefaction potential of soils subjected to earthquakes.

- 1986 ASTM Standard D4633 Standard Method for Stress Wave Energy Measurement for Dynamic Penetrometer Testing Systems
  Incorporates NIST research results to assess the strength and liquefaction potential of soils subjected to earthquakes.

- 1985 Action Plan for Abatement of Seismic Hazards of Existing Buildings
  NIST participated in development and technical review.

- 1987 Action Plan for Abatement of Seismic Hazards to Lifelines
  NIST participated in development and technical review.

Post Earthquake Investigations

Post earthquake investigations provide direct, experimental evidence of the effectiveness of seismic design and construction practices and guide research by identifying needs and opportunities for indepth investigations. NIST conducted and reported significant investigations for the following earthquakes.

- San Fernando, California, 1971. Recommended development of NEHRP provisions and design standard for highway bridges.

- Managua, Nicaragua, 1972. Recommended design and regulatory practices for seismic safety for Nicaragua.

- Guatemala, 1976. Observations of successful performance of modern buildings.

- Romania, 1977. Led to new information on the performance of large panel structures in earthquakes.

- Miyagi-ken-oki, Japan, 1978. Led to calibration of Japanese and U.S. data correlating soil testing results with liquefaction potential.

- Imperial County, California, 1979 with EERI. Provided detailed information on the development of inelastic deformation and failure mechanisms in structures.

- Mexico City, 1985, with USGS. Showed importance of site amplification, duration of strong shaking and hammering on seismic performance of buildings.

- Whittier, California, 1987. Led to significant studies, funded by NSF and conducted by others, of performance of previously strengthened masonry buildings.

- Armenia, 1988. Reconnaissance shows good performance of large panel reinforced concrete structures, but collapses of concrete lift slab and precast frame structures.

Research

- Analyses of recommended seismic design provisions to provide for complete, consistent and clear expression of new, research-based technologies for application in practice.

- Consistent load factors for various structural materials and loadings (including earthquake) to provide consistent reliability over alternative structural systems and potential environmental actions (occupancy loads, wind, snow, earthquake, etc.)

- Measurement of the liquefaction potential of soil deposits to allow control of a major source of earthquake losses.

- Development of unique laboratory facilities for the study of structural behavior under seismic loads. These include the 6 degree of freedom tri-directional testing facility and the large structural testing facility capable of compression loads up to 12 million pounds and shear loads up to 1 million pounds on specimens up to 60 ft tall with lateral displacements up to 24 inches.

- Strength and energy absorption of unreinforced and moderately reinforced masonry to provide rational bases for assessing existing buildings and to provide cost-effective seismic resisting masonry in areas of moderate seismic hazard.

- Strength and energy absorption of bridge piers under simulated seismic loading, figure 2, to assess the effectiveness of current design provisions for California, define scale effects in seismic testing, and provide reference data for the development and verification of analytical procedures.

- Studies of the performance near full scale of connections for braced steel frames to verify design practices and allow effective use of braced frames in highly seismic regions.

- o Study of seismic performance of precast concrete frame connections in the unique six-degree-of-freedom structural testing device will provide bases for practices for the safe use of precast concrete structures in seismic zones.

- o Study of performance of metal anchors used to connect additional reinforcing elements to existing structures will provide bases for practices for strengthening existing buildings that have inadequate seismic resistance.

- o Study of methods for assessing structural stiffness and damping insitu to assist in determining resistance of or damage to existing structures.

- o Study of procedures and criteria for locating strong motion instrumentation in Federal buildings to assure effective aquisition of performance data in earthquakes.

Research Needs Studies

- o National Earthquake Engineering Experimental Facility Study, Phase I - Large Scale Testing Needs, 1987, conducted at the request of the President's Office of Science and Technology Policy.

- o Steel Research Needs for Buildings, 1985, conducted in cooperation with the National Science Foundation, the American Iron and Steel Institute, the American Institute of Steel Construction and the Metal Building Manufacturers Association.

Collaborative Activities

- o Interagency Committee on Seismic Safety in Construction includes 25 Federal agencies. NIST provides chairman, chairman of subcommittee on buildings, and co-chairman of the subcommittee on post-earthquake investigations.

- o U.S.-Japan Panel on Wind and Seismic Effects includes 16 U.S. Federal agencies and 9 Japanese agencies. NIST provides the U.S-side chairman. UJNR has:
  - held 20 annual technical meetings for prompt exchange of research findings
  - conducted 30 workshops and conferences, on topics such as repair and retrofit of structures, involving leading U.S. and Japanese researchers and practitioners.
  - conducted cooperative post earthquake investigations.
  - provided access for U.S. researchers to unique Japanese facilities.
  - organized cooperative research programs on steel, concrete and masonry structures.

- o International Council on Building Research, Studies and Documentation (CIB). NIST has provided the President 1983-86 and the chairman of the Programme Committee 1986-89. CIB provides recommendations for

international standards on structural resistance to earthquakes and international cooperation on earthquake hazard reduction.

- o International Union of Laboratories for Testing and Research on Materials and Structures (RILEM). NIST provided the president 1982-85, and continuing leadership in development of the technical programs. RILEM is developing recommended practices for the seismic performance testing of structures.

- o NIST participates actively in over 100 national and international standards development activities. NIST provides the Chairman of the Technical Council of Codes and Standards of ASCE, a major developer of standards for seismic safety.

- o NIST serves on the Oversight Committee of the National Center for Earthquake Engineering Research established by NSF at SUNY-Buffalo.

REFERENCES

[1] The National Earthquake Hazards Reduction Program, Executive Office of the President, June 22, 1978.

[2] Earthquake Hazards Reduction Act of 1977: Authorization for Fiscal Years 1988 and 1989, House of Representatives Report 100-89, Part 2.

[3] Earthquake Engineering Research - 1982, Committee on Earthquake Engineering Research, National Research Council.

[4] Commentary and Recommendations of the Expert Review Committee, The National Earthquake Hazards Reduction Program, 1987.

[5] Five Year Plan for 1989-1993, National Earthquake Hazards Reduction Program, 1988.

NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM

Fiscal Years 1979 - 1989

	79	80	81	82	83	84	85	86	87	88	89
STRS $K (Base)	324	369	510	494	547	510	502	518	528	536	525
Work Years	4.5	5.9	5.7	4.7	6.1	5.5	5.1	6.1	5.2	5.9	5.0
OA $K (Reimburs.)	16	477	33	200	561	747	786	819	261	367	378
Work Years	.2	5.0	.3	2.4	6.1	6.2	7.3	7.0	2.5	3.4	3.1

March 21, 1989

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

April 6, 1989

OFFICE OF THE
ASSISTANT DIRECTOR
FOR ENGINEERING

Honorable Ernest F. Hollings
United States Senate
Washington, DC 20510

Honorable Albert Gore, Jr.
United States Senate
Washington, DC 20510

Dear Senators Hollings and Gore:

Thank you for allowing the National Science Foundation (NSF) to provide written comments on the National Earthquake Hazards Reduction Program (NEHRP) and on S.629 in connection with your April 7 hearing.

The NEHRP Five Year Plan for 1989-1993 consists of nine program elements. NSF plays a major role in two elements: Earthquake Engineering Research and Fundamental Earthquake Studies. NSF is also significantly involved in the elements of Information Systems and Dissemination, Post-earthquake Studies, and International Cooperation.

NSF's Directorate for Engineering is responsible for the Earthquake Engineering Research element and the Directorate for Geosciences is responsible for the Fundamental Earthquake Studies element.

The research program in Engineering supports fundamental investigations in engineering and the social sciences directed toward mitigating the effects of earthquakes. The goal is to strengthen the existing knowledge base in earthquake engineering and related disciplines in order to minimize the loss of life and resources due to earthquakes. NSF's earthquake engineering research program began in the early 1960s and became a part of the NEHRP with the passage of the National Earthquake Hazards Reduction Program Act (1977), along with the program now in the Geosciences Directorate. In the Geosciences Directorate, basic research is supported on the fundamental causes and conditions for earthquake occurrence, including research on earthquake mechanisms, crustal movements, and seismology.

The NSF earthquake research activity is divided into five components in the two directorates.

ENGINEERING DIRECTORATE

Siting and Geotechnical Systems-

Research in this area addresses the fundamental engineering issues related to earthquake ground shaking and describes earthquake interactions on geologic structures including surface and subsurface soil and rock systems. The primary research areas are strong ground motion, stability of geotechnical systems, tsunami systems engineering and lifeline systems.

Structural Systems-

In this part of the program research support is aimed at developing the capability to predict the behavior of structures and lifeline systems during earthquakes, establish practical guidelines and methods for engineering design against earthquake loading, and provide economically feasible methods to strengthen existing hazardous systems. This includes research to develop new and reliable design methodologies, computer simulation, knowledge-based computer systems, damage assessment methodologies and hazard evaluation of existing buildings.

Architectural and Mechanical Systems-

Research in this portion of the program is focused on architectural and mechanical components and systems whose failure during an earthquake could result in loss of life, damage, economic losses and social disruption. Examples are architectural and mechanical components in buildings such as glass and exterior cladding, elevators, building mechanical systems, power generation and transmission facilities, building contents, communication systems and masonry structures in which architectural and structural systems may be integral parts. Motion control systems such as provided by dampers, active control systems and base isolation devices are also considered.

Earthquake Systems Integration-

This component supports research and related activities to integrate knowledge-producing and knowledge-using systems. Key areas of research include earthquake mitigation planning; earthquake preparedness planning; impacts, recovery and reconstruction; and technology delivery. Multiple disciplinary issues relevant to earthquake hazard reduction are addressed under this element including topics in engineering, architecture, planning and social science.

GEOSCIENCES DIRECTORATE

Earth Sciences Division

This research develops the fundamental understanding of the tectonic conditions necessary for earthquake occurrences and provides a framework for earthquake prediction and hazard evaluation. Areas of research include plate tectonics, crustal structure, seismology, crustal deformation and volcanism and landslides related to earthquakes. These subjects provide the scientific basis for more applied programs of earthquake forecasting and prediction, and ground motion prediction.

EFFORTS IN CENTRAL AND EASTERN USA

It is important to note that research conducted by NSF researchers usually has broad based application and can generally be directed toward earthquake hazard mitigation efforts throughout the United States. However, it is also true that the knowledge base and hazard awareness are more developed in the western United States than in other parts of the nation. NSF has several activities which are focused on earthquake hazard mitigation east of the Rocky Mountains. Some of these are listed below.

- The National Center for Earthquake Engineering Research (NCEER)- Although this is a national center, it is headquartered at the State University of New York at Buffalo and it focuses a significant portion of its research on areas of concern to the eastern and central United States. This is done in the areas of ground motion and site response, performance of existing and new buildings, protective and secondary systems, lifelines, and disaster research and planning, education and public awareness.

- ABK Research Program- This multi-year project resulted in a methodology for retrofitting existing unreinforced masonry buildings to resist seismic forces. The results are applicable to all seismic zones in the U.S. Implementation of the methodology and results is currently underway in Charleston, SC.

- Coordinated Redesign Research Project- This research project is being organized by NSF as a multi-institutional, multi-principal investigator and coordinated research activity to provide a basis for repair, retrofit, and upgrade of existing structures to resist seismic forces. These results will be applicable to all regions of the country including the central and eastern United States.

- Precast Seismic Structural Systems- This research project is being organized as a multi-institutional, multi-principal investigator coordinated research project to provide fundamental engineering data for design and construction of precast concrete structural systems in seismic zones. Some of these structures are vulnerable to seismic forces like those in Armenia and they are widely used in both the central and eastern United States.

- Technology Transfer and Information Dissemination- NSF currently supports technology transfer and information dissemination programs which have nationwide impact. These include:

  - The Technology Transfer and Information Service program at the National Center for Earthquake Engineering Research.
  - National Information Service for Earthquake Engineering at the University of California at Berkeley and California Institute of Technology in Pasadena.
  - National Hazards Information Center, University of Colorado.
  - Jointly sponsored conferences and workshops on technology transfer and information dissemination such as those recently held in San Diego, Denver, Knoxville and Chicago in cooperation with the other NEHRP agencies.

NSF believes that coordination between the principal and contributing NEHRP agencies is being achieved. NSF co-sponsors projects of mutual interest with the U.S. Geological Survey (USGS), the National Institute of Standards and Technology and the Federal Emergency Management Agency. NSF also jointly funds research projects with NEHRP contributing agencies such as the Naval Facilities Engineering Command, the U.S. Army Corps of Engineers, and the U.S. Air Force Engineering and Services

Center. The Interagency Coordinating Committee and the Interagency Committee for Seismic Safety in Construction are important to the integration of NEHRP programs and NSF strongly supports these efforts.

NSF has examined S.629 which would amend the Earthquake Hazards Reduction Act of 1977. We believe that our role in the NEHRP has been successful in reducing the earthquake hazard and we will actively participate in all additional efforts to enhance the earthquake hazard reduction efforts. Our research projects have produced results that have been incorporated into engineering practice and earthquake hazard mitigation and planning. We do not believe a new lead agency is required. Our current role in the NEHRP--to produce high quality, cutting-edge research in earthquake engineering and the geosciences--should continue. Accordingly, we oppose S.629.

The NSF appreciates the opportunity to comment on the NEHRP and S.629. The Office of Management and Budget has advised that there is no objection to the submission of this report from the standpoint of the Administration's program.

Sincerely,

John A. White
Assistant Director
for Engineering

cc: Honorable John C. Danforth
Honorable Larry Pressler

Southeast
Missouri State University

COMMERCE COMMITTEE
1989 JUN 27 AM 9:24

497 Senate Russell Office Building
Constitution & Delaware Avenues, N.E.
Washington, DC 20510
June 20, 1989

Dear Senator Danforth:

Fiona Branton has sent me copies of the bills S.629 and S.1062. I am particularly pleased with S.1062, which you are cosponsoring with Senator Gore.

I agree with you entirely in that we need to focus more on applications of established research to improve earthquake safety rather than on more basic research. We already know a great deal about protecting people from earthquake injuries and losses, but much of what we know as engineers and scientists is not yet in practice.

You will be pleased to know that applied technology is the focus of the newly created Center for Earthquake Studies here at Southeast Missouri State University. We are an "Earthquake Mitigation" center, dedicated to implementing programs that will ultimately save thousands of lives and billions of dollars in reduced property losses over the next decades. Your bill is exactly the kind of legislative support we need to accomplish our task.

If you ever need information, testimony, or any assistance in the earthquake hazard reduction area, please let me know. I and the Center for Earthquake Studies stand by to serve you. We greatly appreciate what you do.

Sincerely,

David Stewart

David Stewart
Director

cc. Fiona Branton

DS/df

Center for Earthquake Studies • College of Science and Technology
One University Plaza • Cape Girardeau, MO 63701-4799 • (314) 651-2000

24-223 (132)